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HUMAN RIGHTS AND PEACE

DURING the first autumn of the Second World War a Declaration of Human Rights was drafted by Mr. H. G. Wells, who suggested that it should be adopted as a statement of Allied aims and an expression of the spirit in which we face life in general. More than nine years later the essence of the ten clauses proposed by Mr. Wells has found expression in the thirty articles of the Charter of Human Rights adopted by the General Assembly of the United Nations in Paris on December 10. Much that has happened in the interval has engendered a certain scepticism as to the value of what can equally be described as a Declaration of Peace Aims. The long debates and discussions of the past two and a half years which have issued in the Charter seem at times to encourage the view that it is essentially a manifesto of ideological warfare expressing the ideals and beliefs of Western civilization.

Any such cynicism should be checked by the realization that no government in existence, even in the Western world, is able to guarantee to all its citizens all the rights laid down. These rights are proclaimed for everyone without distinction of any kind, and the Declaration is clearly meant to apply equally to those who are furthest from attaining them. Only the last two articles, with their emphasis on duties and responsibilities, in any way limit those rights. "Everyone has duties to the community in which alone the free and full development of his personality is possible"; and the only limitations on the exercise of human rights and freedoms are declared to be such as are determined by law "solely for the purpose of securing due recognition and respect for the rights and freedoms of others and of meeting the just requirements of morality, public order and the general welfare in a democratic society".

Safeguarding the State may obviously be made an excuse; but the exercise of State interference in accordance with elastic interpretations of democracy is limited by the final article: "Nothing in this Declaration may be interpreted as implying for any State, group or person any right to engage in any activity or to perform any act aimed at the destruction of any of the rights and freedoms set forth herein". Moreover, the inclusion of such reservations in a separate general article does not detract from the strength of the rest so much as would a succession of reservations to the individual articles. It is also worth noting that there has been a surprising degree of unanimity in adopting the successive provisions, and that this provision of a common standard of achievement is to lead to a later international covenant which will be even more binding.

Certain of the articles are vague, and the differing interpretations of such words as 'freedom', 'impartial', or 'protection' is bound to introduce some uncertainty, particularly in the economic field, at least until some such common tradition as lies at the basis of Western Union becomes of world-wide validity. Nevertheless, many of the articles can scarcely be misunderstood, and they supply strong support for

the individual or the professional association in any demands for fulfilment they may have to make upon the State. There was, indeed, strong resistance from the Communist bloc to the inclusion of the right to freedom of movement and residence within the borders of each State, of the right of a person to leave his own or any other country and to return, to freedom of thought, conscience and religion, and the sharing of the common cultural life; but the majority of the United Nations declared firmly for the provision of universality at the start of the Declaration and the sufficiency of the reservations at the end.

Clearly the Declaration embodies the principles which men of science have long held to be essential for the full vigour of a fruitful scientific and creative life, and the debates from which the Declaration has emerged can leave them in no doubt as to where the real dangers to scientific activity lie to-day. The Declaration obviously calls for close consideration from the Committee on Science and its Social Relations, and from the General Assembly of the International Council of Scientific Unions, in view of the resolution adopted by the latter Assembly in July 1946 and a subsequent declaration on the principles of a charter for scientific men since adopted by the Committee. It equally deserves consideration by that growing body of scientific workers concerned with ways in which science could help towards the maintenance of peace.

A comprehensive report on science and the maintenance of peace has been prepared for the Committee on Science and its Social Relations, but an interim report was issued by B. J. Bok, chairman of the U.S. National Research Council Committee of the United Nations Educational, Scientific and Cultural Organisation, for use at the Boston meeting of the United States National Commission on the latter body in September 1948. In that report, Mr. Bok attempted an analysis of the twenty-two replies received to two questions addressed during the summer to some forty representative scientific workers. Replies to the first question, dealing with the measure in which the methods of international scientific work contribute to the creation of an international spirit and to the maintenance of peace, almost all stress the international character of science. Many clearly feel strongly that, because of the special nature of their work, they are in a favoured position with regard to international collaboration, though some believe that scientific contact alone has comparatively little to do with securing peace.

Much stress was laid in the replies to this question on the effectiveness of international exchanges of scientific workers at all levels, and on the value of international exchanges of scientific literature and advances in scientific abstracting. Moreover, the replies recognize the importance in this connexion of several projects undertaken by the Natural Sciences Department of the United Nations Educational, Scientific and Cultural Organisation, such as the establishment of the Field Science Co-operation Offices, the Hylean–Amazon Institute and the work on scientific reconstruction. One reply emphasized that the method of science assists men to put aside the conventional reactions and prejudices that hinder our understanding of unfamiliar things; and that the evolutionary character of scientific theories helps to provide the flexibility of mind necessary for the maintenance of peace in a world so varied and diverse. The principle of freedom of inquiry, it is claimed, is a great asset in the maintenance of world peace because it is hard to reconcile with doctrinaire politics and dogmatic adherence to particular social or political theories. Whether or not this belief is too optimistic—and it was strongly attacked by implication by Dr. A. P. Lehner in his comments in the *Bulletin of the Atomic Scientists' Association* on a suggestion that scientific men and engineers should refuse to participate in weapons research and development—this view indicates sufficiently why the man of science cannot wisely neglect to support the Declaration of Human Rights, or to follow with interest the activities of the United Nations Educational, Scientific and Cultural Organisation.

The replies received to the second question, referring to the ways in which scientific organisations and individuals could intensify their activities for the maintenance of peace, yielded a number of suggestions with which the activities of Unesco are wholly in line, notably those in connexion with the forthcoming Scientific Conference on the Conservation and Utilization of Resources. Strong support was forthcoming for continuing the work of the international scientific unions and for increasing personal contacts among scientific men all over the world.

Nevertheless, the prevailing opinion seems to have been that it is a matter of hope rather than of history that the increasing knowledge of the world, improved communications and transport of goods and raised standards of living can minimize the causes of war by reducing stimuli to aggression. Prof. H. C. Urey sees the establishment of world government as our ultimate aim, but despite the general agreement that science fosters peace rather than war, Dr. K. T. Compton is supported in his view that the responsibilities for peace of scientific workers are just the same as those of any other group of citizens. He does not believe that it is feasible or, in the long run, safe for men of science to attempt to exert their own controls on the products of their work; and in this view Dr. H. N. Russell concurs, pointing out that the maintenance of peace is so entangled with sincere differences of social and political belief that it would be unwise for scientific organisations, as such, to endorse any particular programme. Dr. Lehner develops this point more particularly in his article in the *Bulletin of the Atomic Scientists' Association* already noted, and shows the difficulties to which the assumption by men of science of special responsibilities in this way would lead. There is no solution, he urges, in giving power to leaders of science, for they, too, are men; and the economist comes firmly down on the same side, urging that the most those who want peace can do is to try to

guide their fellow men by participation in political action for the world government that is necessary for peace.

At the meeting at Boston on September 28 when this interim report was discussed, Dr. A. H. Compton suggested that there are four ways in which it is appropriate for the United Nations Educational, Scientific and Cultural Organisation to use science towards the maintenance of peace. The first is by emphasis on human values; science and technology should be considered as means for attaining these values. The second is insistence on freedom and honesty in our search for knowledge. Next comes the development of science on a world-wide front, giving the opportunity for scientific men themselves to become the prototypes of the world citizen and thus to provide for all nations natural channels of human intercourse with their neighbours. Finally, there is the encouragement of the growth of science and technology throughout the world. Dr. Compton appears to regard this last as the most powerful existing force working towards world peace.

These suggestions were generally approved at that meeting, and a resolution adopted for forwarding to the United States National Commission urged that scientific men should work for the maintenance of peace in four ways: (*a*) They can emphasize and develop the human values associated with science and technology, and (*b*) insist on freedom in their search for knowledge. (*c*) Because of the natural one-worldness of their fields, they can consciously serve as prototypes of world citizens, and (*d*) by systematically promoting international co-operation, they can contribute directly to world integration and the construction of the defences of peace.

The subsequent report of the Committee of Science and its Social Relations issued in November 1948 gives an analysis of some seventy replies to the two questions, but its trend is sufficiently well shown by Bok's interim report, although some of the individual opinions quoted in the final report deserve attention. Generally, the replies to the first question testify to the existence of an international spirit among men of science, and regard its existence as favourable to the development of other aspects of international co-operation, in particular that of union, because men devoted to honesty, objectivity and freedom of scientific investigation, whatever their nationality, influence favourably other fields of human relations. Although one group of replies to the first question considers that men of science can exert a direct influence on the political world, either by appropriate public declarations or by the formulation of moral or ethical codes of conduct, the great majority see the most favourable possibilities of action in their normal activities. All correspondents, however, were unanimous in insisting on the necessity of intensifying their support of the projects for co-operation initiated by the United Nations Educational, Scientific and Cultural Organisation and by the international unions. Indeed, the whole inquiry brings out once more the independence of the scientific attitude, and the general belief among men of science that the fundamental contribution of science to world peace lies in the support it gives to freedom of thought, investigation and publication and the free circulation both of ideas and of men.

Little fresh has thus come out of the inquiry, and it may well be urged that the value of scientific work in creating an international spirit and encouraging the movement of thought across national frontiers needed no such demonstration. Nevertheless, some of the replies are valuable as indicating the dangers that lurk in proposals for direct political action by men of science as such. Perhaps more important is the demonstration of the existence of a substantial body of opinion which is following the activities of the United Nations Educational, Scientific and Cultural Organisation with interest and is capable of the cogent and constructive criticism of its activities which the Organisation needs. It is unfortunate, whatever the cause, that so little interest is taken in those activities in Great Britain. Parliament is obviously not interested, and there is no indication whether the universities, the professional organisations, the Churches and those practical people engaged in education, science and cultural activities generally are satisfied that the right projects are being attempted in the right way. A vigorous defence of the general purpose and policy of the Organisation was, it is true, offered by Mr. Ronald Gould at the recent conference on higher education held by the National Union of Teachers in London. Mr. Gould was careful to distinguish between criticism of administration, which might be merited, and destructive criticism of objectives.

However sound the fundamental conception of the United Nations Educational, Scientific and Cultural Organisation, that purpose of fostering co-operation and understanding among all peoples will only be achieved through the free flow of thought and expression throughout the world. The close support and keen interest of scientific workers is as essential a factor here as their support, interest and criticism are for the formulation of practical projects by which international co-operation and understanding can be furthered. The general indifference to the proceedings of the Organisation's recent meeting at Beirut is the more disappointing, for there was evidence that an attempt is being made to rectify past mistakes. Plain speaking is still required, and the most hopeful feature of the inquiry set on foot by the Committee on Science and its Social Relations is that it shows there are responsible men of science in the International Council of Scientific Unions who recognize the potentialities of Unesco, and whose standing ensures a hearing for any criticism they may have cause to make of its programme or administration. If such criticism is to be fully effective and this means of using science for furthering the maintenance of peace is to succeed, there must be public as well as scientific scrutiny; and one duty which scientific workers as citizens should undertake is to see that the projects of such an international body are rigorously scrutinized, the good approved and supported, and the weak exposed firmly but constructively as the obstacles they are in truth to the cause of international understanding.

THE COMPLETE CORRESPONDENCE OF LEEUWENHOEK

The Collected Letters of Antoni van Leeuwenhoek Edited, illustrated and annotated by a Committee of Dutch Scientists. Vol. 3: 1679–1682. Pp. viii+565+48 plates. (Amsterdam: Sweta and Zeitlinger, Ltd., 1948.) n.p.

THE third volume of this stupendous work includes letters 43–69 (old enumeration 28–36), and covers the period April 1679–July 1682. Seven of the letters, however, are those which have either not been recovered or have no scientific value, but which are properly catalogued in order to maintain the completeness of the record. It is of interest to note, but withal disappointing, that the new material now brought to light is of no great importance, and hence the letters already wholly or partly published in various quarters have so far not proved to be seriously deficient. Perhaps the most significant point to be established in the present volume is the date when Leeuwenhoek first discovered the nucleus of the animal cell. In the printed Dutch and Latin versions of letter 67 (35) it was doubtful whether he had seen the nucleus of the oval red corpuscles of fishes; but the original drawing now photographically reproduced for the first time shows clearly that he had seen the nucleus of the fish red corpuscle in March 1682. His next reference to the nucleus, this time in squamous epithelium, was in 1686. The etched figures in the Dutch and Latin "Opera" do not show the nucleus.

Among the diverse researches which Leeuwenhoek describes in these few letters are the following: spermatozoa of man and various animals, and how their number is estimated; the question whether spermatozoa and animalcula are complete miniature organisms with all the parts of larger complex forms; Hooke's demonstration to Charles II of some freshwater Infusoria (*not* spermatozoa); ciliary action of Infusoria and the gills of the oyster, and its uses; first mention of his observation of blood capillaries; viviparous generation in the female vinegar-eel; microscopic structure of the vessels of wood; histology of the testis of rat; discovery of anaerobic bacteria; impossibility of spontaneous generation; mechanism of the circulation of the blood; lacteal vessels of lamb and calf; biology of yeast; generation and anatomical notes on various insects and mites; microscopic structure and growth of hair in man and pig; discovery of the human intestinal flagellate *Giardia*; microscopic structure of striated muscle in vertebrates and invertebrates; nucleated red blood-corpuscles of fishes. On all these matters Leeuwenhoek produces new observations and acute inferences to the enlightenment of astonished readers.

In our previous reviews of this work (*Nature*, 144, 956, and 157, 3) we took occasion seriously to criticize its English translations. In the present volume the English version is very greatly improved and modernized. It is true that now and again the idiom is somewhat un-English, but without unduly affecting the interpretation. Thus a literal translation has not usually a 'literary' value, a gradually darkening border becomes a "slowly shadowing contour", an author "lays his views down" when he publishes them, the labial palps of the oyster appear as the "flaps" of the mouth, the ciliary action of the gills of the oyster "dabbles" the water, Leeuwenhoek's Royal Society diploma with appended seals appears ambiguously as a "sealed" diploma, and so on. These may not be considered serious defects; but they do underline the contention, which we have already twice maintained, that the English translation should be revised by an English biologist. Surely a great and essential work, such as this enterprise undoubtedly is, deserves, if it does not demand, the final polish.

The commentaries on the text supplied by a large group of specialists are especially valuable, but are occasionally unacceptable and more rarely inaccurate. The following points may be mentioned: p. 7, the statement that, according to the Dutch and Latin "Opera", there may be more than "10,000 thousand" animalcules in a space equal to one sand grain of matter does not occur in the Latin versions but only in the Dutch. P. 59, the blood capillaries were not first referred to in the letter of May 20, 1679, but in two letters of February 11, 1675, and May 14, 1677. P. 211, in *Mytilus*, Leeuwenhoek observed the *discrete* nature of the gill filaments and also the ciliary junctions; but he was not aware how they functioned in holding the filaments loosely together. The interpretation of the commentator would suggest that he was not too familiar with the structure of the gills of *Mytilus*. P. 229, line 6, for 1886 read 1686. P. 243, the first Latin edition of letter 62 has been accidentally omitted. P. 259, there are no gastroliths in the crab, which negatives the view that they constitute a reserve of calcareous material for use in the formation of a new shell. For such a purpose they are manifestly inadequate. They may be formed from the lime known to be abstracted from the shell before moulting to ensure that the process is unattended by amputations; but the same objection applies to this interpretation though to a less extent. The gastroliths figured in Plate 34 were obviously taken from the lobster. P. 323, the *big* horse-fly could scarcely be a *Hæmatopota*, and still less a *Stomoxys*. Why not a *Tabanus*? P. 331, the eggs of a gnat, notes Leeuwenhoek, had a *very clear* spot on one *side*. The commentator interprets this as the micropylar process, which does not tally with what Leeuwenhoek says. The clear spots might be the nuclei of the oocytes.

The Letters are followed by a reasoned critique by van Iterson, in which it is claimed that Leeuwenhoek's studies on the structure of wood (magnified seventy times) were largely independent of the contemporary works of Malpighi and Grew, and were in many respects superior to them. Leeuwenhoek is credited with being more restrained and intuitive in his deductions. Van Iterson is followed by Dijksterhuis, who reviews and collates the mathematical terms and micro-metric methods adopted by Leeuwenhoek, and in another place there is a list of the weights and measures employed in the Letters. The 48 plates of the volume introduce such extra figures as are necessary for the interpretation and illustration of Leeuwenhoek's observations and speculations, and, what is more important, we now have photographic reproductions of all Leeuwenhoek's own drawings, which may profitably be compared with the copper plates of the earlier printed editions. The book is completed by a bibliography and biographical notes on the authorities quoted in the text, and there is a good index.

The Leeuwenhoek Commission is to be handsomely complimented on its determination to continue the publication of this great historical work in the

sumptuous style of the two volumes printed before the War. In Holland, apparently, questions of space, paper and binding have few terrors for the publisher. Last, but far from least, the large public unfamiliar with the Dutch language will be very grateful for the English translation.

F. J. COLE

THE GLOUCESTERSHIRE FLORA

Flora of Gloucestershire

Phanerogams, Vascular Cryptogams, Charophyta. Edited by the Rev. H. J. Riddelsdell, G. W. Hedley and W. R. Price. Pp. clxxxii+667+44 plates. (Cheltenham: Cotteswold Naturelists' Field Club, 1948.) n.p.

IT is remarkable that so important a botanical area as the county of Gloucestershire should have had to await for so long the consummation of an account of its flora. The project was first conceived by the late Prof. Boulger some seventy years ago, and he had by 1878 compiled a list of more than a thousand species from this area. Nevertheless, except in respect of the Bristol region and casual records, very little real progress was again made until the impetus given by the Rev. W. Butt in 1905, and from 1908 to the time of his retirement by the Rev. H. J. Riddelsdell, who compiled what constitutes the main substance of the present work. But, though belated, the outcome is a Flora that is worthy of the botanical wealth which it enshrines.

There are here recorded 1,126 native species, 40 denizens and 23 colonists—a total of 1,189 species of vascular plants that includes such rarities as *Cephalanthera rubra*, the red helleborine, *Ranunculus ophioglossifolius* the adder's-tongue buttercup, and *Trinia glauca*, the honewort. Of all the species here enumerated, sixteen are noted as having become extinct, and of these, as is usual in other counties, the greatest proportion, namely, nine, are damp-habitat plants. Four of the extinct species are seaside plants and one is characteristic of woodlands.

The revision of names in accord with international rules has produced a number of unfamiliar labels for familiar friends, changes which cannot but be deplored when they do not reflect any increase of botanical knowledge. One new species is here described and figured under the name of *Epipactis cleistogama*.

The Flora is planned upon traditional lines, the records being grouped in respect to nine botanical districts. An unusual feature is the provision of keys to some of the groups, such as the Batrachian Ranunculi by Dr. Butcher, the Carices by Mr. Nelmes and the Gramineæ by Mr. Hubbard. The last-named has provided keys not only to the species in each of the genera but also to the genera themselves.

Gloucestershire has for the student of plant distribution an especial interest, since various species are here at or near their geographical limit. The pasque flower (*Anemone pulsatilla*) and *Senecio campestris*, both members of the Continental element in the flora of Britain, attain here their western limit, and this is true also of the Continental orchids, *Orchis ustulata* and *Himantoglossum hircinum*. But the ground pine (*Ajuga chamæpitys*) and the spider orchid (*Ophrys aranifera*) do not extend into the area. The endemic aconite (*Aconitum anglicum*), which is essentially a western plant in England, is here probably at its eastern limit, though, since it is stated that some of the records are probably garden escapes, the doubt arises whether the endemic plant has been adequately distinguished from its cultivated congener. The western *Andromeda polifolia*, on the other hand, has its eastern limit to the west of Gloucestershire. Again, the northern *Prunus padus* here attains its southern limit; but the local *Phyteuma tenerum*, though found in Wiltshire, fails to reach the chalk of Gloucestershire. These few examples suffice to indicate the importance of distribution data for this area and the need for biological studies in respect to such marginal species.

The present work is a notable addition to the county Floras of Britain and a valuable contribution to the literature of geographical distribution of plants in Britain. The text is embellished with views of typical Gloucestershire habitats and portraits of some of the rarer and more interesting species.

E. J. SALISBURY

ELEMENTARY PHYSICS

A Laboratory Manual of Physics

For Higher Certificate, Scholarship and Intermediate Science Students. By Dr. F. Tyler. Pp. 207. (London: Edward Arnold and Co., 1947.) 7*s*. 6*d*.

Intermediate Physics

By Dr. C. J. Smith. Third edition. Pp. xii + 1033. (London: Edward Arnold and Co., 1947.) 18*s*. net.

Electricity

Text Book and Laboratory Manual for Inter.B.Sc., Higher School Certificate, University Scholarships, etc. By M. M. Das. Pp. xi + 483. (London: T. Murby and Co., Ltd., 1947.) 25*s*. net.

General Physics

By A. E. E. McKenzie. Pp. viii + 499. (Cambridge: At the University Press, 1948.) 8*s*. 6*d*. net.

DR. F. TYLER'S collection of experiments is intended to cover the practical work required for higher school certificate and university scholarships, and also for first-year university courses. Most of the really profitable class experiments which can be done with simple apparatus are included, and this carefully chosen list probably represents the highest common factor of all courses of this standard. Instructions, of the kind usually issued to students as 'manuscripts', explain the operations required, and show how the readings should be set out and the results calculated. The theory of each experiment is given in some detail, and, where the results are to be plotted, notes on the full interpretation of the graph are supplied.

Laboratory manuals can only reveal their quality in class, and it so happens that the reviewer has tried the book for more than a term with a small set of boys who had to work with little direct supervision. The results were satisfactory, and the pupils liked the book, which serves its purpose very well. Criticisms which arose in use are that the problem on the oscillation of a loaded tube on page 15 is more difficult than it appears, since the timing of more than a few oscillations is impossible; the directions for the

location of neutral points in experiment 66 are those usually given, but are inadequate (it is suggested that Owen's method might be described in future editions, since this does find a point rather than a somewhat large area); and in the metre-bridge experiment it is surely better to calculate separate values for the resistance, and take the mean, than to average the balance-lengths first. The importance of recording each observation is stressed in the introduction, yet, in some cases, heights which are differences between observations are to be written in the notebook; and, since the accuracy of the observations is supposed to be estimated, some assistance in this might have been given by including a few lines of instruction below the actual observations.

Some small points perhaps deserve reconsideration. It is a half-truth to say that lycopodium sets in small heaps at the nodes in Kundt's tube experiment; the remarks on the cooling-curve experiment of p. 129 are inconsistent with the excellent discussion of Newton's law of cooling on p. 125; the chief purpose of the lid in the method of cooling is to prevent evaporation from the calorimeter; and if the width of the aperture in the Clément and Desormes experiment is considered, this is really a problem on critical damping—it is wrong to imply that oscillations occur with narrow rather than wide tubes when the reverse is the case. Perhaps it would be better also to discuss the damping correction for the ballistic galvanometer before the first experiment in which it is used, since this correction is often quite considerable, and should always be made.

The book is free from serious errors, and the instructions are unmistakably clear. It can be recommended as a valuable laboratory guide which both teachers and pupils should find most useful.

In its third edition, Dr. C. J. Smith's "Intermediate Physics" appears thoroughly revised and to some extent re-written. In the general physics section a short account of the method of dimensions has been added; in the heat chapters a full account is given of methods of determining thermal conductivity, and the chapter on radiation is chiefly new. The work on optical instruments has been considerably extended, and though the laterally expanded diagrams of ray traces at first look a little ungainly, their value is evident when one has become acclimatized to them; this kind of diagram is certainly something to commend to examination candidates. The section on wave-motion and sound is interesting, and does not sacrifice precision in order to economize the student's mathematics; this is, of course, work which is valueless unless it is done thoroughly, and there are no half-measures here. The account of Lissajous figures has been expanded; and the Doppler effect is very neatly done. In the electricity section, new material on dielectric theory and magnetometry has been included, and the chapter on electromagnetic induction revised.

The result is a very satisfying book, which not only includes all the material from which Intermediate examiners select their formal exercises, but also gives abundant guidance on those matters about which the better students themselves often ask such searching and shattering questions. Examples of this are the treatment of the Lees disk experiment for bad conductors, and of that frequent motion for debate, the simple magnifying glass.

Some experiments are described in detail—usually those which require some special care and are more difficult than students expect. Several good demonstration experiments which are old, but not often quoted, make a welcome re-appearance, and there are modern versions (which should work well) of some of the more temperamental of the stock repertoire.

The account of modern physics is necessarily brief. The author modestly says it is "just sufficient to whet the student's appetite for more, but not sufficient to distract him from the more fundamental parts of the subject". It might be said that Dr. Smith's admirable exposition of the fundamentals defies distraction; in any event, the last chapter contains all that one expects Intermediate or first M.B. candidates to know of this work.

The book is intended for scholarship candidates as well as Intermediate students, and what it really does is to cover the topics of the Intermediate syllabus at scholarship level; that is, although one would expect a scholarship boy to have read more widely, he would probably not need to go more deeply into the work that is presented here.

Few errors would be expected in a book which has reached its third edition after fifteen years of class use, and none was found; the words 'chemical' for 'thermal' on p. 204, and 'mainspring' for 'hair-spring' on p. 751, are ingenious misprints rather than errors. The production and binding are good, and, for a book of this size and quality, the price is very reasonable.

Mr. M. M. Das's text-book, of Intermediate standard, on electricity deals with the mathematical theory of the magnetic and electric fields side by side in the opening chapters, and then discusses atomic structure before proceeding with the further development of the subject-matter. The treatment of magnetic measurements and magnetic materials is well done, in rather more detail than one usually expects at this stage, and the theoretical calculations throughout the book are clearly explained, particular attention being paid to the question of units. It is intended that the book should serve as a practical manual as well as a text-book, and while many of the experimental instructions are clear and adequate, they strike one as being, on the whole, too brief. There are a number of misleading slips: the theory of the quadrant electrometer is worked out plausibly by equating the *gain* of potential energy of the system to the work done on the fibre; "a new unit of potential, employed in nuclear physics, is the electron-volt"; atomic weight and mass-number are identified; and it is stated that the penetrating power of X-rays is inversely proportional to the wave-length. The price of the book seems unduly high, and would, one imagines, prevent any wide adoption as a class-book. For twenty-five shillings, too, we might have been given the answers to the numerical examples. But the author has thought out his own method of presentation, and teachers in search of ideas will scan the book with interest.

Mr. A. E. E. McKenzie has selected the appropriate material from his well-known series of text-books so as to include in a single volume all the work needed for the rather limited physics syllabus of the school certificate general science paper. The book covers this ground lucidly and well. It embodies all the pleasing features of the earlier ones, and has some new and relevant illustrations, selected with an artist's eye. There was an obvious need for such a book, and Mr. McKenzie has filled it satisfactorily.

G. R. Noakes

Inductance Calculations

Working Formulas and Tables. By Prof. Frederick W. Grover. Second printing. Pp. xiv+286. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 31*s.* 6*d.* net.

PROF. F. W. GROVER makes an authoritative selection among the numerous formulæ which have been suggested for the calculation of mutual and self inductances. He does not attempt proofs of the formulæ, but gives adequate references to the original papers. He gives sufficient explanation of general principles to allow the adaptation of the formulæ to particular cases which are not directly covered (an improbable contingency, however). As the majority of exact formulæ are cumbersome to use, he usually offers numerical tables giving an accuracy of 1 in 1,000 or better, with some indication of the accuracy. Where interpolation between tabulated values would be inaccurate, he gives either alternative formulæ or tables using a different argument. Every likely shape and relative disposition of circuit element is included. There are formulæ for deeply wound coils, and for coils of spaced turns of round wire or of flat tape. The discussion of inductance at high frequencies is less precise than the rest of the book—excusably so, in view of the uncertain effects of self-capacitance. (Here is a field for some useful new work.) The mechanical forces between inductors are also calculated.

The most serious criticism is that the detailed contents pages do not atone for the lack of an index. The "Appendix" promised on p. 26 proves, on diligent search, to be Chapter 22 (which is not the last in the book). Most of the tables are admirably set out; but the type is sometimes small, for example, on p. 84, where it is difficult to count the zeros preceding the significant figures. There is a real need for a work of reference of this kind, and the increased scope of this book, as compared with its predecessors, makes it very useful indeed. A. C. LYNCH

Organic Evolution

By Prof. Richard Swann Lull. Revised edition. Pp. xx+744+31 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 40*s.* net.

ALTHOUGH bravely marked as "Revised Edition" on the title-page, this appears to be no more than a reprint of the revised edition of 1929, which was itself not greatly modernized from the original of 1917. Perhaps it would have been kinder to have allowed this old favourite to go out to grass on the upper shelves of the library. The sections on adaptation to different environments, and the chapters on the evolutionary comparative anatomy of various groups of animals still provide an easily read, if out-of-date, introduction for elementary students. But the sections dealing with the processes of evolution are pathetic. The single short chapter on "Heredity", for example, contains fairly long paragraphs on such pre-genetical ideas as atavism, telegony, prenatal influence and the transmission of parental conditions; and although a sentence is inserted stating that "What is called telegony does not actually exist", the discussion leaves the definite impression that all four ideas are more or less acceptable biological concepts. The following paragraph on sex determination achieves the noteworthy feat of discussing this problem without once mentioning chromosomes; but the discussion on Mendelism, after devoting a total of four pages to an explanation of the F_2 1 : 2 : 1 ratio, does reach out towards the present sufficiently to incorporate a final two lines: "Mendel's laws, therefore, are apparently a generalisation of the greatest importance and apply universally to all cases of inheritance". C. H. W.

Copsford

By Walter J. C. Murray. Pp. 164+23 plates. (London: George Allen and Unwin, Ltd., 1948.) 12*s.* 6*d.* net.

IN many branches of physical science the amateur is inevitably becoming less important; in the observational branches of natural science his place is still as secure as it was in the days of Gilbert White, Jefferies or Hudson; and occasionally someone appears who shows the contribution which the non-professional can still make not only to our knowledge of natural life but also to its significance for the well-being of man.

Such a one is Walter J. C. Murray, whose "Copsford" gives us perhaps one of the most intimate accounts of Nature since Hudson wrote his "Far Away and Long Ago" some thirty years ago. Murray spent a year in a lonely cottage with neither road nor footpath connecting it with human habitation, working among the wild life which surrounded him. There he struggled with the elements, earned a living by harvesting wild herbs and waged continual war against the legion of rats which contested his right to live in Copsford.

He has now written a book about the countryside which is full of the most intimate experiences among the wild life of woodland and meadow, marsh and brook. In his book the author conveys the impression that he not only lived among wild things but also with them, light and darkness, sound, scent and movement becoming as vital in his life as in theirs. This strange, amusing and exciting story is told in prose which in itself is a pleasure to read. "Copsford" deserves the widest possible acquaintance.

T. H. HAWKINS

The Phasian Bird

By Henry Williamson. Pp. 341. (London: Faber and Faber, Ltd., 1948.) 10*s.* 6*d.* net.

IN this latest volume from his pen Mr. Henry Williamson tells of life on a Norfolk farm during the Second World War, taking as his hero a bird, namely, a hybrid pheasant. With the pheasant as principal character—it was seemingly a cross between the common pheasant and Reeves' pheasant—and such subsidiary characters as "Pertris" and "Pertrisel", the partridges, we see not only the wild life of this corner of eastern England but also the farm life, both human and animal. It is a tragic picture that Mr. Williamson paints, a picture of endless effort to cultivate the stern land, of despair and bitter frustration, of endurance and grim determination that win through, all depicted in the author's well-known vivid style.

F. P.

Interaction of Water and Porous Materials

(Discussions of the Faraday Society, No. 3, 1948.) Pp. ii+294. (London and Edinburgh: Gurney and Jackson, 1948.) 30*s.* net.

THE discussion on this subject held by the Faraday Society during March 31–April 2, 1948, was reported in an article in *Nature* (**161**, 629; 1948). The full text of the papers has now been published, with accounts of the discussion at the meeting.

STELLAR EVOLUTION AND THE EXPANDING UNIVERSE*

By F. HOYLE
t. John's College, Cambridge

THEORIES of the expanding universe have all been constructed in accordance with the following data:

(*A*) The distribution of nebulæ over the sky is approximately uniform, the approximation becoming better as fainter nebulæ are used in the compilation of the statistics.

(*B*) A relation, discovered by Hubble and Humason, exists between the red shift $(\delta\lambda/\lambda)$, usually denoted by δ, of the whole spectrum of a nebula, and its apparent magnitude m. This relation, which can be written in the form

$$\log_{10}\delta = 0{\cdot}2\,m - X, \qquad (a)$$

where X is an observed constant, has been verified for apparent magnitudes less than 18, and is independent of the directions of the nebulæ relative to the earth.

It has been generally accepted that (*A*) can be taken as demonstrating the large-scale homogeneity and isotropy of the spatial distribution of matter, and all theories work in an approximation in which the material in the nebulæ is regarded as being smeared out into a uniform background. In terms of Einstein's theory of general relativity, Weyl interpreted (*B*) as showing that, in the same approximation, the world lines of different elements of material form a bundle of geodesics without envelope that spread outwards from a point. This postulate much simplifies the solution of Einstein's field equations, which, in a common notation, take the form

$$G_{\mu\nu} - \tfrac{1}{2}g_{\mu\nu}G + \lambda g_{\mu\nu} = -\varkappa T_{\mu\nu}, \qquad (b)$$

where λ is a cosmical constant. For, by choosing geodesic co-ordinates, a universal time can be defined that leads to a comparatively simple expression for the line element. A detailed review of the models derived on this basis has been given by Robertson[1].

(*A*) and (*B*) do not exhaust the available data concerning the expanding universe. Thus, Hubble and Tolman have attempted to use:

(*C*) the observed distribution of nebulæ as a function of apparent magnitude,

as a criterion for deciding between the various models satisfying (*A*) and (*B*). It is now generally agreed, however, that a substantial reduction in the errors of measurement is necessary before this criterion can be decisive. The required improvements will eventually be forthcoming from the 200-inch telescope at Mount Palomar. In the meantime, other criteria can be developed from the results of astrophysical research. Among the more important of these results the following may be briefly mentioned:

(*D*) The brightest stars observed in the central regions of nearby spiral nebulæ, in globular clusters and elliptical nebulæ are of closely comparable luminosities. A consideration of the origin and development of these stars yields ages of about 5×10^9 years for the nearby nebulæ. The method used in this determination appears devoid of substantial error; it seems fairly certain that the ages could not be less than 3×10^9 years or greater than 7×10^9 years.

(*E*) In spite of the steady conversion of hydrogen to helium and higher elements, taking place within the stars, which amounts to the transformation in 10^9 years of about 0·1 per cent of the hydrogen present in the nebulæ, hydrogen still constitutes about 99 per cent of all material.

(*F*) The rapidly increasing evidence in favour of the widespread existence of internebular material makes it difficult to resist the conclusion that the nebulæ represent condensations in an internebular medium. The density in such a medium could not be greater than the lowest densities, of about 10^{-24} gm. per cm.^{3}, observed in the nebulæ themselves. On the other hand, the density could not be much less than 10^{-27} gm. per cm.^{3}, otherwise the period required for nebular condensation would become unacceptably large.

(*G*) There is a marked clustering tendency among the nebulæ. Clusters vary greatly in size from pairs of nebulæ up to those containing more than a thousand densely packed members. This indicates that the internebular medium is unstable against the formation of localized condensations; that is, a condensation, following essentially Newtonian dynamics in its internal structure, must be formed wherever the density in a particular region exceeds the mean density in the general background.

We now mention briefly the reasons why models, satisfying (*A*) and (*B*) and equations (*b*), are nevertheless unsatisfactory. The following cases may be distinguished. (i) *Oscillatory universes.* (*F*) and (*G*) can be satisfied, but *E* is an overriding difficulty. These models contain material of finite density but of infinite age. Thus the irreversible conversion of hydrogen into helium and higher elements would have exhausted the hydrogen content of the universe, in contradiction with the observed predominance of hydrogen. (ii) *Universes with zero cosmical constant (excluding oscillatory cases).* These models have a point source origin and are of finite age. But the ages given when (*B*) is satisfied are not appreciably greater than 10^9 years. Accordingly there is a direct contradiction with *D*.

(iii) *Universes with non-zero cosmical constant (excluding oscillatory cases).* It is convenient to treat these models in the following order: (*a*) *The Lemaître–Eddington universe.* By choosing an appropriate relation between the cosmical constant and the density of matter in the uniform background, Einstein found that a static finite universe could be obtained. It was shown by Eddington[2] that this universe is unstable against a perturbation of volume; an increase in volume leading to an unlimited expansion that had been discussed previously by Lemaître[3].

This model is in contradiction with (*D*) and (*G*). For condensations can form only during the pre-expansion stage, on account of the disruptive effect of the cosmical constant. But an infinitesimal perturbation of the Einstein state requires such condensations to have infinite ages. Even for a finite

* Substance of a series of lectures given at the Royal Institution on October 26, November 2 and 9.

perturbation, such as that considered by Eddington[4], the ages are of order 5×10^{10} years. The origin of a finite perturbation sufficiently large to give ages appreciably less than 5×10^{10} years raises what appears to be a fatal difficulty.

(*b*) *The Lemaître universe.* There is an infinity of point source models possessing unlimited expansion. The nebulæ are not appreciably older than 10^9 years in the models of shortest age. On the other hand, there is a model of infinite age that passes through the Einstein state with infinitesimal velocity. Between these two extremes it is possible to obtain a model with an age of 5×10^9 years. Thus (*D*) can be satisfied for a suitable choice of the initial conditions.

This model fails, however, as all point source models do, on account of (*F*). For, in the early stages of expansion, the material in the general background is unstable against the formation of condensations. Thus condensations would be formed in material with density much higher than the mean densities within the nebulæ. No such condensations are observed. Detailed considerations show that this crucial objection cannot be overcome through the action of gas or radiation pressure. (The work of Adams[5], as interpreted by McKellar[6], requires the present background temperature to be not greater than about 1° K., from which it can easily be shown that the thermal energy density is everywhere very small compared with the energy density of matter. Although, according to the theory, the ratio of thermal energy to the rest energy of matter was greater in the past, such an increase in the importance of thermal energy is far from being sufficient to invalidate the present argument.) It may also be noted that, due to the effect of the cosmical constant, *G* also presents a serious difficulty.

Before considering new possibilities, the suggestion may be dismissed that the universe might be static, the observed red shifts of the spectra of the nebulæ being supposed to arise from some unknown cause. This notion fails for the same reason that oscillatory universes are unsatisfactory. Thus, since a static universe is of necessity of infinite age, no hydrogen could be present on account of the irreversible conversion into helium and higher elements. Nor can the difficulty of obtaining a satisfactory system of cosmology be ascribed to Einstein's formulation of relativity. A similar situation appears to arise in Milne's kinematical relativity, which leads to a universe having considerable similarity with the case, mentioned above, of zero cosmical constant. Indeed, the remarkable demonstration by Milne and McCrea[7], that Newtonian analogues exist for all the models discussed above, clearly shows that the solution of the cosmological problem must be sought in an essentially new concept.

Accepting the red shifts of the nebular spectra as indicating expansion, the outstanding question may be stated in the form: Why do condensations not exist with mean densities much greater than the observed mean densities in the nebulæ?

At first sight, expansion seems to require that the density of matter in the general background must in the past have been much greater than the observed mean densities in the nebulæ. This leads to the impasse that dense condensations would certainly have been formed. The difficulty can be avoided by supposing that expansion does not require the background density to have been greater in the past. For this condition to be satisfied matter must be created continuously. The idea of continuous creation is not new. Jeans[8], and more recently Milne[9], have discussed the possibility of explaining the origin of the spiral arms observed in many nebulæ in terms of the creation of matter at their centres. Dirac[10] has emphasized the cosmological importance of continuous creation, and this question has been considered by Bondi and Gold[11] and also by the writer[12].

The homogeneity requirement (*A*) suggests that creation takes place uniformly in the general background, rather than at the centres of the nebulæ, as suggested by Jeans. Weyl's postulate, mentioned above, provides a convenient means of formulating continuous creation in mathematical terms. The main effect is to introduce a new tensor in the left-hand side of (*b*). Putting λ equal to zero, it can then be shown that there is but one steady-state solution of the field equations. Moreover, whatever the initial conditions, this state is reached in a comparatively short length of time.

The condition (*G*) is satisfied. That is, the material in the background is always unstable against the formation of condensations, although when averaged on a very large scale the density is uniform not only in space but also with respect to the time co-ordinate. The line element is identical with the well-known de Sitter form. This requires a relation (*a*) to be strictly satisfied. The theoretical value of X can be arranged to agree with the observed value by an appropriate choice of the creation-rate, which is the only free parameter in the theory. This leads to a background density of about 5×10^{-28} gm. per cm.^{3}, and a creation-rate of about 10^{-43} gm. per cm.^{3} per sec. The latter value is far too low to be observable in the laboratory.

Bondi and Gold[11] have shown that (*C*) is also satisfactorily explained in the present model. This agreement with observation is particularly noteworthy, for, once the creation-rate has been fixed so as to give agreement with the observed red shifts, no adjustable parameter remains in the theory (in contrast with many other models), which therefore stands or falls according as to whether (*C*) is accounted for or not.

Although the present universe is of infinite age, individual nebulæ possess finite ages. Investigation shows that nebulæ observed to be receding from the earth must have theoretical ages lying between 2×10^9 years and about 10^{10} years. The individual field nebulæ are associated with the lower age limit, and the great nebular clusters with the upper age limit; that is, the number of nebulæ contained in a cluster is a measure of its age. According to (*D*), nearby nebulæ have an age of about 5×10^9 years. This indicates a moderate degree of clustering in the neighbourhood of our galaxy. It is satisfactory that this requirement is in agreement with observation, which shows that our galaxy is a member of a local group of nebulæ.

(*E*) is satisfied provided the created material consists either of hydrogen or of neutrons. (*F*) is automatically satisfied for a background density of 5×10^{-28} gm. per c.c.

It is not the purpose of this article to enter into the philosophical implications of the continuous creation of matter. Nevertheless, the following two points may be mentioned. (*a*) The resulting universe possesses both an infinite past and an infinite future throughout which the large-scale properties must remain unchanged. Thermodynamics has only localized significance. There is no large-scale 'running

down' towards a general heat death. (*b*) Eddington attached much significance to a coincidence between the observed value of X and a number that can be built up out of the constants of microscopic physics. This coincidence, which is probably of great importance, appears in the present theory as a relation between the creation-rate and the microscopic constants. The existence of this relation is a warning that the theory in its present form is probably far from being complete. At the same time it provides a hope that a deeper understanding of the creation process may ultimately be forthcoming.

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INFRA-RED SPECTROSCOPY WITH THE REFLECTING MICROSCOPE IN PHYSICS, CHEMISTRY AND BIOLOGY

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A. R. H. COLE*
AND
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During recent years infra-red absorption spectroscopy has been applied in a variety of physical and chemical problems. For example, the individualistic character of a molecular vibrational absorption spectrum has been used in the chemical analysis of mixtures of complex organic substances[1], and the constancy of the vibration frequencies of particular atomic groupings assists diagnostic work on polymers and other compounds of high molecular weight, or on substances of chemotherapeutic interest[2]. Another application is the study of the structure of the solid state, and the use of polarized infra-red radiation here promises to give important information[3].

Although it has been possible by means of the so-called 'powder' technique to obtain spectra with only a few milligrams of material, there are many cases—particularly with new antibiotics or other extracts—where even this small quantity is not available, at least in the early stages of an investigation. The matter may also be complicated by having to use liquid paraffin as a base for the powder, since its absorption bands often overlie spectral regions of interest. The desirability of being able to use extremely small amounts of material becomes greater in biological problems such as the measurement of spectra of individual cells, of fibres, or of tissue sections. For all these reasons some form of microscope has long been desirable. Also the applications with polarized infra-red radiation would be much simplified if it were possible to use a small crystal of material or oriented fibre, rather than having a fairly large artificially prepared layer or film.

The microscope has already been used in spectroscopy, both in the visible and ultra-violet[4]. In the latter case, Caspersson[5] and others have used a quartz refracting instrument with success. This method has shortcomings, however, since the instrument must be refocused as the wave-length is changed, and absorption by the system of lenses restricts the spectral range available. The development by Dr. C. R. Burch of a reflecting microscope[6] therefore leads to an important extension of the whole method, since the achromatic nature of the instrument and the entire absence of absorbing materials make it serviceable from the extreme ultra-violet to the far infra-red. Using a continuous source of radiation, such as the hydrogen discharge tube, it has been possible[7] to measure the ultra-violet and visible spectrum of cystals and blood cells. The investigation of spectral changes as different parts of a cell are measured is of great interest.

On the other hand, the use of ultra-violet absorption spectra has certain limitations. Difficulties may arise, for example, because of photolysis; but more important, the band systems of complex molecules are too often composed of broad absorption maxima which are not very specific in revealing the nuclear skeleton of the molecules involved. In this respect, the greater specificity of vibrational spectra in the infra-red has often been emphasized.

We have therefore been fortunate in being able to use the Burch microscope with a Perkin Elmer recording infra-red spectrometer, and have now obtained spectra between 2 and 15 μ of particles, without recourse to slit-widths so large as to reduce the spectral resolution too badly. Prisms of rock salt and lithium fluoride have so far been used, but there seems no reason why the range should not be extended to longer wave-lengths with a prism of potassium bromide. Radiation from a Nernst glower passes through the microscope and sample, emerging to give a magnified image (100–1,000-fold), which can be seen by the eye. The sample is placed on a thin plate of rock salt, quartz or other transparent material. By means of a small preliminary slit of variable aperture, different parts of the object can be selected, and the radiation through these parts directed by means of focusing mirrors on to the entrance slit of the spectrometer. The weight of substance used in the present work is in general 10^{-7}–10^{-8} gm. The minimum size of particle which can be used depends on the resolving power of the microscope, which in turn varies with the wave-length. We have, however, obtained good records with crystals and fibres 20–50 μ in diameter. We have also been able to investigate polarization effects using a selenium mirror following the microscope, the sample under examination being rotated in a horizontal plane.

Some examples of the results so far obtained are described briefly in the following.

(1) It was required to measure the spectrum of a minute crystal of 'bialin', which had been extracted

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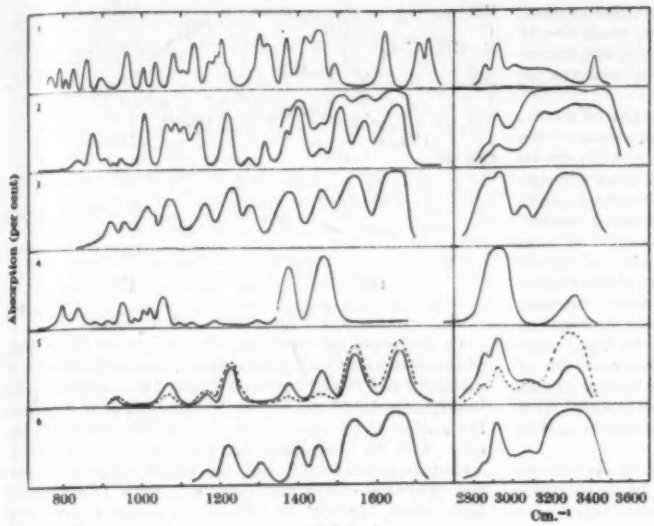


Fig. 1

1. Bialin.
2. Antipernicious anæmia extract (vitamin B12).
3. Gramicidin B.
4. Cholesterol crystal.
5. Full curve, frog nerve fibre; dotted curve, frog nerve after extraction with chloroform.
6. Frog muscle fibre.

from the mould *Penicillium Bialowiczense*, and in particular to establish its identity, or otherwise, with a similar small crystal of mycophenolic acid obtained from *Penicillium brevi-compactum* (Dierckx). The spectra proved to be identical over the region 2–14 μ; further, using higher dispersion in the region of 3 μ, the behaviour of the two samples in polarized radiation was exactly similar (Fig. 2, *C*). Any other method of establishing this identity with such small quantities of material would perhaps have been impossible, and chemical methods would certainly have required much more material. Another important point is that the use of paraffin as a base for the powder is avoided, and the important regions of the C—H absorption bands are not obscured.

(2) A small crystal of the antipernicious anæmia factor (vitamin B12) isolated by E. Lester Smith[8] was examined with a view to structural diagnosis. From the spectrum shown in Fig. 1 (2), it is seen that the stretching vibrations of CH_2 and CH_3 groups lying near 2,900 cm.$^{-1}$ are comparatively weak, and this is indeed paralleled by the weak nature of the corresponding C—H deformational modes near 1,460 cm.$^{-1}$ and 1,375 cm.$^{-1}$. By contrast, there is a broad region of strong absorption between 3,200 and 3,500 cm.$^{-1}$ which must be due to bonded O—H or N—H groups. This region also appears to have sub-maxima, and one of these may indicate the stretching mode of C—H bonds in an aromatic or heterocyclic nucleus such as the pyrrol or pyrimidine type. The character of the region of O—H absorption is more like that usually found for bonded hydroxyl groups of an alcohol or phenol than that of hydroxyl groups in a carboxylic acid, but further comparison with model substances would be profitable.

Taken as a whole, the spectrum does not show the general features found with a polyamide[9], with which strong bands occur near 1,470, 1,550, 1,640, 2,950 and 3,300 cm.$^{-1}$. The strong band near 1,660 cm.$^{-1}$ may indicate C=C or C=N links rather than peptide C=O groups, which again may occur in a cyclic compound of the kind just mentioned. Correlation of other bands in the spectrum with constituent groups is at present difficult, but it may be noted that, on the basis of other measurements in progress here[10] on the alkyl phosphites, phosphates and phosphonates, there is indication of phosphorus–oxygen links in vitamin B12. If the substance proves after all to be substantially a polyamide in nature, its spectrum must be considerably masked by other parts of the molecular structure.

(3) The spectrum of gramicidin B (Fig. 1, 3) shows the group of five strong bands usually found with polyamides between 1,400 and 3,400 cm.$^{-1}$ as well as the weak band near 3,060 cm.$^{-1}$. In this case the bands at frequencies less than 1,400 cm.$^{-1}$ were broader than usual; but further comparisons with model compounds might lead to correlations with particular amino-acid residues concerned. Samples of insulin gave similar results.

(4) Small quantities of other substances typical of those encountered in biochemistry have been measured, such as cholesterol, tryptophane and methionine. The spectrum of cholesterol (Fig. 1, 4)

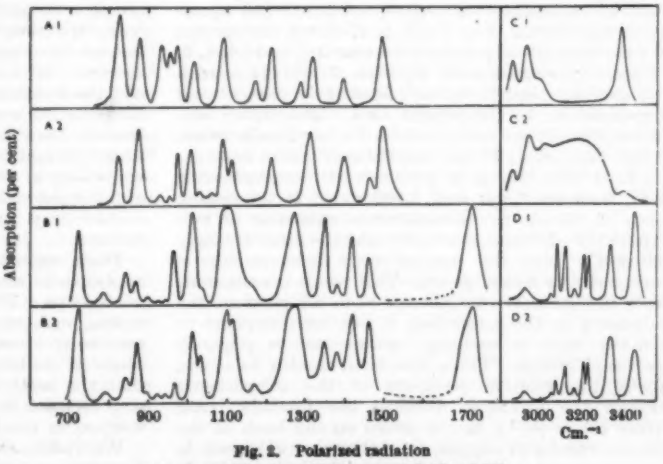


Fig. 2. Polarized radiation

A 1, 2. *p*-Chlorobenzaldoxime crystal, 0° and 90°.
B 1, 2. Terylene fibre, 0° and 90°.
C 1, 2. Mycophenolic acid, 90° and 0°.
D 1, 2. *p*-Nitraniline, 90° and 0°.

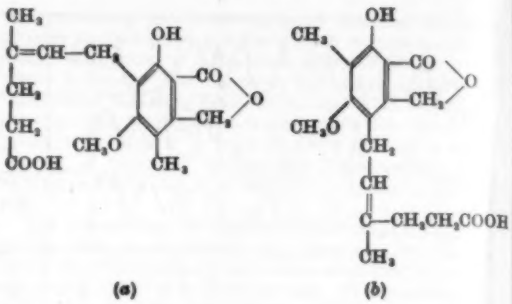
is noteworthy for its relative simplicity, the marked bands due to C—H vibrations and the weak O—H band near 3,420 cm.$^{-1}$. We would again emphasize here the advantages of obtaining the spectra in absence of 'Nujol'.

(5) We have also measured the spectra of fibres, including hair, casein, terylene, muscle and nerve fibres. The spectrum of frog nerve (Fig. 1, 5) shows the main features of a polyamide; but after a rough extraction with chloroform there are marked alterations in the relative intensities of certain bands. This extraction diminishes the strength of the stretching and bending vibration bands of C—H bonds near 2,900, 1,460 and 1,375 cm.$^{-1}$ and causes the bonded O—H group to appear more intense. This is what would be expected for the removal of lipides. The reduction in intensity of the band near 1,080 cm.$^{-1}$ is also consistent with the removal of —C—O— bonds such as occur in esters[11], and in this connexion it is interesting that the strong band near 1,235 cm.$^{-1}$ appears to be in the polyamide rather than the lipide.

The spectrum of frog muscle (Fig. 1, 6) also shows the main features of a polyamide, but at frequencies less than 1,500 cm.$^{-1}$ there are definite differences from the spectrum of nerve, and the relative intensities of the C—H and bonded O—H vibration bands are different in the two cases. It is clear that a more detailed study of this whole problem might be very informative.

(6) The use of polarized infra-red radiation for studying the internal structure of crystals, ordered crystalline aggregates and oriented polymers was previously investigated by Mann and Thompson[12], and later extended by Ambrose, Elliott and Temple[13] and by Jones and Sutherland[14]. Its value in the present work is greater because small single crystals can be used without the need of obtaining large uniformly oriented films, fibres can be studied at successive stages of 'drawing' or orientation, and very small areas of polymer films can be used. Alternatively, in the latter case small areas in a large film of polymers can be studied to compare the degree of order in the structure.

A number of substances were measured for comparison with the earlier work on a macroscopic scale, such as acetanilide and adipic acid, and full agreement was found. Fig. 2 (*D*, 1, 2) shows the spectra of small crystals of *p*-nitraniline near 3 μ, and (*A*, 1, 2) of *p*-chlorobenzaldoxime between 7 and 14 μ, with the incident electric vector respectively parallel and perpendicular to the crystal axis. This figure also shows the corresponding results for terylene between 7 and 14 μ (*B*, 1, 2) and mycophenolic acid near 3 μ (*C*, 1, 2). The change in spectrum with mycophenolic acid between 2,800 and 3,600 cm.$^{-1}$ is interesting since it reveals the simultaneous existence of two types of O—H bond, one feebly and the other strongly 'bonded'; and the bonded type behaves like a carboxylic hydroxyl group. This result is consistent with the structure which has been assigned to the substance in the sense that it has been thought to contain both a carboxyl group and a phenolic hydroxyl group. There has been doubt, however, about the relative positions of the substituents around the aromatic nucleus, the formula being either (*a*) or (*b*)[15]; and it seems on the basis of the present results to suggest (*a*) rather than (*b*), since in the case of (*a*) the steric effects might be more likely to prevent association of the phenolic hydroxyl group.



In the case of terylene, the polyester from terephthalic acid and ethylene glycol, marked changes of intensity are found between 7 and 14 μ, although the band near 1,720 cm.$^{-1}$ due to the carbonyl groups is little affected by directional change. The details of this case will be discussed in relation to the crystal structure elsewhere[16], but we would emphasize here the spectral difference detected with fibres which have been 'drawn' to different extents; and even using unpolarized radiation, some spectral changes have been found between stretched and unstretched samples which can be interpreted in terms of special orientation of certain bonds.

The application to individual small crystals such as those of *p*-chlorobenzaldoxime opens up the possibility of cutting crystals along several principal directions, and thence, from computation of intensity of key bands, the deduction of the crystal structure projections on several planes.

In connexion with the carcinogenic activity of certain derivatives of *p*-dimethyl aminostilbene, it has been suggested that coplanarity or otherwise of the two aromatic nuclei may be related to the electronic structure requisite for activity[17]. Since characteristic bands are now known for the several kinds of substituted aromatic nucleus, the use of polarized radiation in crystals of these compounds might throw light on this problem[18], and measurements of this kind are now being made.

(7) Another line of work which can now be explored is the infra-red spectral absorption of biological cells. We have made preliminary measurements with several samples such as blood, and obtained good spectra. If the intensity of the source of radiation and the numerical aperture of the microscope can be increased, as seems possible in several ways, it should become feasible to examine different parts of the single cell and, in some measure at least, to investigate variations in chemical composition. The possibility of following cellular processes continuously, using the cathode ray tube infra-red recorder, may then be realized.

These examples serve to illustrate the manifold applications which may now be made using the new microscope. There are numerous possible improvements, such as the construction of a microscope of greater aperture, and the provision of a more intense beam of radiation. It seems, however, established that the method will not only form an important step forward in crystal analysis, but also a valuable weapon in much biological work.

We wish to express our appreciation to the Nuffield Foundation for a grant in aid of equipment to be used with the microscope, and also to the American Cyanamid Company for the generous gift of the

infra-red spectrometer used. We are also grateful to all those who have provided materials for study.

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OBITUARIES

Dr. Marjory Stephenson, M.B.E., F.R.S.

MARJORY STEPHENSON was born at Burwell in Cambridgeshire on January 24, 1885; she died in Cambridge on December 12, 1948. She was educated at Berkhamsted School for Girls, and at Newnham College, where she was later to be associate and fellow. As circumstances prevented her following her wish for a medical degree, she equipped herself at the Gloucestershire Training College of Domestic Science, and taught for a time there and at King's College of Household Science, London. Soon she had an opportunity to begin biochemical research work at University College, London, under Dr. R. H. A. Plimmer; her first paper, on animal lactase, was published in 1912. The next year she was aided by a grant from Newnham College, and a little later was awarded a Beit Memorial Research Fellowship; but her newly bogun career was interrupted by the First World War. She served with the British Red Cross during 1914–18, first in France and then in Salonika, where she was V.A.D. commandant. Her work was recognized by the award of the M.B.E. and the Royal Red Cross.

In 1919 she returned to research, this time at the Biochemical Laboratory, Cambridge, with Sir Frederick Gowland Hopkins. At first she took part in the vitamin work already in full swing in the Laboratory, becoming interested in the fat-soluble vitamins. This interest led on to her work, with M. D. Whetham (later Mrs. A. B. Anderson), on the fat metabolism of the timothy grass bacillus, and thence to more general studies of these and of fermenting organisms. She had now found her life-work and remained in Cambridge, in the favourable milieu of Hopkins' department, developing the science of chemical microbiology, and teaching and inspiring a long succession of pupils and collaborators. Her influence became world-wide; she opened up several new fields of study, some of which have since been brilliantly developed by her pupils.

As time went on, Dr. Stephenson became more and more impressed by the importance of chemical microbiology as a special discipline, not only valuable to the community on account of its industrial and medical aspects, but also capable of making a unique contribution to the progress of scientific thought. This theme she developed in her lecture before the congress which celebrated the centenary of Pasteur in Paris in November 1946. For many years she was on the staff of the Medical Research Council, and in 1944 her tireless efforts led to the formation of the Council's Unit for Chemical Microbiology. In 1948 she was appointed to a University readership at Cambridge. She also played a great part in the founding of the Society for General Microbiology and was its president at the time of her death; many will long remember the charm and lively enthusiasm with which she presided over its conference last September. Three years earlier, she and Dr. Kathleen Lonsdale had been the first women to be elected into the ordinary fellowship of the Royal Society.

Her book "Bacterial Metabolism", which so greatly enhanced her international reputation, appeared first in 1930. The third edition, entirely re-written, is now on the point of publication. It is animated throughout by the imaginative insight which enabled her to consider the microbe, not as a useful device or as a pest to be eliminated, but as a living organism going about its own legitimate business.

In her early work, for example, with J. H. Quastel and L. H. Stickland, she dealt with several subjects of which time has only emphasized the importance—for example, the role of —SH groups in metabolism, or the possibility of energy provision under anaerobic conditions by the interaction of specific hydrogen donators and acceptors. She was the first to demonstrate, in cell-free extract, the presence of a specific (lactic) dehydrogenase from bacteria, and her work on hydrogenase and hydrogenlyase (with L. H. Stickland, D. D. Woods and J. Yudkin) has become classical. The observations on these enzymes aroused her interest in the subject of adaptive enzymes, to which she and her school (now including E. F. Gale) made outstanding contributions.

In 1937 she became interested in the importance of nucleic acid derivatives in cell metabolism, and with characteristic thoroughness embarked on a study (with A. R. Trim) of the changes which the adenine compounds themselves undergo in the presence of bacterial enzymes, as a preliminary to studying their mode of action in the cell. Several years later she came back to the theme of nucleic acid metabolism, and her last paper (with J. Moyle), just ready for press, is on this subject. Her latest published experimental paper (with E. Rowatt) was on the bacterial synthesis of acetylcholine.

During the Second World War, Dr. Stephenson carried out (with R. E. Davies) some important

research on the acetone–butanol fermentation, and took a very active part on the Medical Research Council Committee for Chemical Microbiology.

Throughout her years in the Cambridge Biochemical Laboratory, Dr. Stephenson was greatly sought as friend and adviser. She was always ready to pay sympathetic attention, and her advice, usually given quickly and with decision, was based on a deeply considered philosophy of life. One of her great characteristics was her intense interest in people, and a favourite theme in her conversation was the influence of character upon scientific achievement or, conversely, the effect of certain types of results upon the psychology of research workers. She had many interests outside biochemistry, and this fascination by human nature was very plain in her love of the drama and the great nineteenth-century novelists; she was enthralled, too, by the history of the development of civilization and by certain aspects of the theory and history of science. She used to say that, when her laboratory life was ended, she would like to use the leisure of retirement to write biographies of a few of the men of science (Pasteur and Hopkins among them) whom she so greatly admired, and whom she felt that she in some degree understood. In one of the last conversations I had with her, the subject of present-day growing-points in science came up. It was characteristic of her to say: "Let us consider: if Hoppy had started research in Cambridge to-day instead of fifty years ago, where would he have chosen to begin?"

In her later years her interests seemed to grow wider. She had always loved gardening, and she became very keen on horticultural research. She was greatly concerned about the development of biochemical training in general in Great Britain; she was a great advocate of decentralization, and liked to see good workers from more remote places return to act as foci of progress in their own country.

One of her great qualities was her hatred of any form of cant, hypocrisy, pretention or slovenliness; she was ruthlessly outspoken in her condemnation of any such suspected defect. But this personality, so lively and so gifted with the capacity for leadership, had another characteristic: a fundamental humility, which enabled her to listen, learn, and, if need be, change her mind. She had, lastly, a great opinion of the possibilities of youth, and when the risk was debated of entrusting responsibilities to the young, her advocacy was always on their side. She would have applauded Confucius when he said: "The rising generation is to be respected. Who knows what they may accomplish?"

DOROTHY M. NEEDHAM

Mr. T. Petch

MR. TOM PETCH, the well-known mycologist, died at North Wootton, King's Lynn, on December 24 at the age of seventy-eight, after a short illness. Born at Hornsea and brought up at Hedon, he attended the choir school of Holy Trinity, Hull. From Hull and from Yorkshire naturalists he early acquired great interest in plant and animal life, and contributed many original observations to *The Naturalist* and to the Hull Scientific and Field Naturalists' Club.

As a young man Petch taught science and mathematics at King's Lynn Grammar School, and by dint of private study graduated in both arts and sciences at the University of London. At King's Lynn he came under the stimulating influence of the late Dr. C. B. Plowright, then in the very front rank of students of the fungi, and it was this happy contact that led Petch to devote chief attention to the study of these organisms. Later, he taught at the Leyton Technical Institute. One of his friends at this time was the late Mr. George Massee, of Kew, through whom in 1905 Petch was offered the post of Government mycologist in Ceylon at the Royal Botanic Gardens, Peradeniya. He accepted enthusiastically because the post promised greater scope for his interests.

Petch's arrival in Ceylon coincided with a great extension of rubber plantations. He studied in detail the fungus diseases of the rubber tree, then beginning to cause concern, and his researches in this field were most illuminating. In 1911 he published "The Physiology and Diseases of *Hevea brasiliensis*", and in 1921 "The Diseases and Pests of the Rubber Tree", for many years the best books on the subject, acclaimed by men of science and planters alike. He also gave much attention to the diseases of other crops, notably coco-nuts and tea. His book on the "Diseases of the Tea Bush", published in 1923, is a comprehensive account of the pathology of this plant and is still the standard work.

In 1925 Petch left Government service to become the first director of the new Tea Research Institute of Ceylon, which he launched with great success. Being a man of wide vision, he realized that there were many problems in tea production besides the incidence of disease, so he gathered around him a team of experts competent to explore the whole field of inquiry. Petch had the great gift of inspiring enthusiasm and harmony among his colleagues and confidence among the planters. Both the tea and rubber plantation industries are under a deep debt of gratitude to him for most valuable services.

Petch also devoted much attention to the general study of the fungi, mycetozoa, and flowering plants of Ceylon, for he was no mean botanist as well as a brilliant mycologist. For several years he edited the *Annals of the Royal Botanic Gardens, Peradeniya*, which contains numerous contributions from him, among them being "The Mycetozoa of Ceylon", "The Fungi of Certain Termite Nests", "The Phalloideæ of Ceylon", "Revisions of Ceylon Fungi", "Additions to Ceylon Fungi", and "Studies in Entomogenous Fungi". He left Ceylon in 1928 with the reputation of being the world's foremost tropical mycologist.

On retirement to England, Petch devoted the remaining twenty years to the study of fungi, chiefly British groups. His only other major interest was his large garden at North Wootton, which had been designed by the late Dr. C. B. Plowright. Petch was still a most ardent collector and investigator of micro-fungi, and a constant stream of papers emanated from him, published chiefly in the *Transactions of the British Mycological Society*. Among them may be mentioned "British Hypocreales", "British Nectrioideæ", "British Entomogenous Fungi", and a long series on other entomogenous fungi. One of his last efforts was to compile, with Dr. G. R. Bisby, a revised list of Ceylon fungi. Petch had numerous mycological correspondents throughout the world, whom he was always ready to help. He was a most versatile, careful and critical worker, and he corrected many errors of description and nomenclature made by others.

Unfortunately, few honours came Petch's way; but one which he much appreciated was the confer-

ment of honorary membership of the British Mycological Society, of which he had been president in 1920. He was also president of the Yorkshire Naturalists' Union in 1931. Petch was a Yorkshireman of decided but completely honest views, the staunchest of friends, and a most interesting companion.

Petch married in 1908 the daughter of the late Dr. C. B. Plowright, of King's Lynn, who survives him, together with a son and a daughter. His extensive mycological collections have been bequeathed to the British Museum (Natural History).

F. T. BROOKS

M. Georges Truffaut

BY the sudden death in September last of M. Georges Truffaut, science has lost an international figure. Married to an Englishwoman, he spent much time in Britain during his younger days, and frequently visited Rothamsted, East Malling, Long Ashton and Cheshunt. From each of these he gathered much that interested him, and he created at Versailles a laboratory in which he conducted much research on partial soil disinfection, in which he was inspired by the ideas of Sir John Russell. He investigated the bacterial fixation of nitrogen under the influence of electric light, work initiated, or at least inspired, by his work at Rothamsted, and later, in his Versailles laboratory, his attention was led towards the use of colouring matters, at first in agriculture and later in horticulture.

Truffaut was early involved in the determination and use of various colouring matters as weed eradicants. In 1936 he was invited by the Royal Horticultural Society to visit London to put forward the results of his work, at a time that the utilization of 'Sinox' was still in its infancy. As things turned out, he and his laboratory were not able to carry out the extension of their programme as was done in the Anglo-Saxon countries, but they contributed to the development of the processes to the full measure of their abilities. In his last days Truffaut was occupied in working out a new formula for weed eradication which was more economic as well as more active; but his death occurred before these could be put forward. Had he lived, we should probably have heard more of him and his work in connexion with weed eradication.

WE regret to announce the following deaths:

Dr. Andrew Connal, O.B.E., formerly director of the Medical Research Institute, Lagos, on January 26.

The Right Hon. Lord Melchett, formerly deputy chairman of Imperial Chemical Industries, Ltd., on January 22, aged fifty.

Prof. John Percival, emeritus professor of agricultural botany in the University of Reading, on January 26, aged eighty-five.

NEWS and VIEWS

Chemistry at the Australian National University: Prof. Adrien Albert

DR. ADRIEN ALBERT has been appointed the first professor of chemistry in the John Curtin School for Medical Research, Australian National University. Arrangements have been made for the Department of Chemistry to be located temporarily in the Wellcome Research Institution, 183 Euston Road, London, N.W.1, until the necessary buildings have been erected in Canberra, when Prof. Albert will supervise their completion and equipment. Prof. Albert graduated in the University of Sydney in 1932 with honours in chemistry, and in 1937 was awarded the degree of Ph.D. of the University of London. He returned to Australia in 1938 as a research fellow in the Organic Chemistry Department of the University of Sydney, where he remained until 1947. He has recently held a research fellowship at the Wellcome Research Institution.

Defence Services Research Facilities Committee

AT the invitation of the Council of the Royal Society, the Lords Commissioners of the Admiralty, the Army Council, the Air Council and the Ministry of Supply have appointed representatives on a Defence Services Research Facilities Committee. The terms of reference of the new Committee are as follow: "To consider proposals for the use of Service facilities and personnel for assisting scientific research, and to make recommendations to the Council of the Royal Society, the Lords Commissioners of the Admiralty, the Army Council and the Air Council". The Committee has been constituted as follows: *Chairman*, Sir Geoffrey Taylor; *Royal Society*, Prof. P. M. S. Blackett, Sir Harold Spencer Jones, Dr. A. C. Menzies, Mr. F. S. Russell; *Admiralty*, Vice-Admiral A. G. N. Wyatt (hydrographer), Mr. F. Brundrett (C.R.N.S.S.); *War Office*, Lieut.-General Sir Kenneth Crawford (D.C.I.G.S.), Dr. O. H. Wansbrough-Jones (scientific adviser to the Army Council); *Air Ministry*, Air Vice-Marshal C. E. N. Guest (assistant chief of Air Staff—Operations), Mr. G. S. Whittuck (head of *S*.6); *Ministry of Supply*, Dr. F. J. Wilkins (principal director of scientific research—defence), Mr. H. M. Garner (principal director of scientific research—air).

The Committee proposes to conduct its business through panels of scientific men and Service representatives who are specially interested in specific projects, and at its first meeting panels were formed to cover the following subjects: (*a*) submarine gravity measurements, (*b*) surplus explosives, (*c*) magnetic survey, (*d*) aerial photography, (*e*) scientific expeditions. Scientific workers wishing to submit proposals for consideration by the Committee should communicate their suggestions in the first instance to the Assistant Secretary, Royal Society, Burlington House, London, W.1.

Giant Sunspot and Geomagnetic Storm

A VERY large group of sunspots of 'bipolar' type crossed the solar disk during January 16–29. At central meridian passage on January 22·7 U.T., the middle of the group passed 28° above the centre of the disk. Two big spots were the chief components, with their centres separated 12° in longitude, or approximately 85,000 miles. The aggregate area of the spots for several days was about 2,300 millionths of the sun's hemisphere, or about 55 times the cross-section area of the earth. Greenwich data show that

sunspots of this order of size are very likely to be associated with geomagnetic storms beginning within the time-limits of two days before and four days after central meridian passage of the spot group. A severe geomagnetic storm did, in fact, occur, commencing abruptly on January 24 at 18h. 28m. U.T. The disturbance continued with even increased vigour to the night of January 25–26. Displays of the aurora were widely seen on both nights in Great Britain. Provisional overall ranges recorded at Abinger of the earth's magnetic elements (kindly communicated by the Astronomer Royal) are as follow: D, 1° 29′; H, 660 γ; V, 490 γ. Long-distance radio-communication was seriously affected during the period of the geomagnetic storm.

Although a close connexion between the magnetic storm and the solar region containing this giant spot group can scarcely be doubted, there is little evidence at present for the occurrence of a brilliant solar flare some 24 hours before storm onset. Such a flare may have occurred, however, during the Greenwich night hours, and observations are being sought from observatories recording during 18h.–0h.–6h. U.T. either (*a*) direct solar observations; (*b*) radio anomalies that occur in the earth's day hemisphere when flares occur; or (*c*) a characteristic 'crochet' impulse on magnetograms that likewise betrays the occurrence of the more intense flares. Apart from this, there is increasing evidence that the stream of solar particles involved in the occurrence of a great magnetic storm is ejected at the time of an intense flare within the central region of the sun's disk.

Geological Survey in the British Commonwealth

In an article in the *Petroleum Times* of January 1949, a "Petroleum Geologist" puts forward proposals for a British and Commonwealth plan for a modern geological survey. He lays emphasis on the fundamental importance of geological survey, and on the urgent need for an appraisal of the mineral resources of the Commonwealth. He recognizes that the development of the surveys depends on the expansion and training of staff and on the provision of specialist services in such fields as palæontology, geophysics and air survey. The lay-out of the organisation which he advocates accepts the essential independence of the surveys of the several Dominions, but involves a closer relationship between the Geological Survey of Great Britain and the Colonial geological surveys; he proposes that these should be placed under a Minister (or his nominee) with an advisory board, and that specialist services should be joint. The comparison with the organisation of some oil companies is not helpful, however; both in Britain and in the Colonies, geological surveys have a much wider range of interest than an oil company, and procedures suitable for the rapid exploration of oil resources are not necessarily adaptable for a survey which, to be economical, must deal concurrently with many topics. Moreover, while it is true that greater freedom of interchange between Britain and the rest of the Commonwealth is valuable, the differences in the nature of the problems met with, and the importance of individuals with great local knowledge, limit the possibilities of useful interchange. We believe that the Geological Survey of Great Britain is itself as fully engaged on economic problems as "Petroleum Geologist" could desire, while the new organisation of the Colonial surveys promises important and rapid progress as men can be recruited.

Autumn Bird Migration in Britain

Several very interesting items occurred during the autumn of 1948 with bird movements in Britain. On August 21 and 22 an American greater yellowshank (*Totanus melanoleucus*), the sixth British record, appeared at Ecton Sewage Farm, Northamptonshire, where a grey phalarope, the first county record since 1902, and an osprey appeared in September. On September 13 an American pectoral sandpiper (*Calidris melanotis*) appeared at Salthouse Marsh in Norfolk, another was reported from Sinderland, in Cheshire, on September 10, and a third at Thorney Island, Sussex, on October 3. On September 9 an immature cormorant (*Phalocrocorax carbo*) with four legs was obtained at Seaforth, Lancashire; later it died in Liverpool, but X-ray and other photographs were taken for the Merseyside Naturalists' Association. A grey phalarope also appeared at Worsley Sewage Farm, Lancashire, on September 5. On November 11 a little bunting (*Emberiza pusilla*) was added to the bird records of Cumberland by R. Stokoe, a careful observer, at a roadside pool at Siddick, near Workington. Whooper swans were on the same water, and earlier that month on Derwentwater. A gadwall was shot at Frodsham, Cheshire, early in December. Ringed bird returns have included this season a turnstone in Cheshire, marked by Stavanger ornithological station in Norway; and a Manx shearwater found at Leigh, Lancashire (an inland location), on September 5, was marked at the Skokholm colony, South Wales, as recently as August 28.

The Animal Health Trust

Reviewing the ten-monthly period ending June 1948, the second report of the Animal Health Trust describes the completion of the requisition of land and buildings for the Trust's Canine Research Station at Newmarket and the Farm Livestock Research Station at St. Ives. At the former, research has been restricted to studies of a clinical nature including para-distemper, night blindness and Scotch cramp, while at the Poultry Research Station, established on the fifty-acre parkland adjoining Houghton Grange, St. Ives, diseases of the respiratory track have been the priority subjects of investigation. Progress has also been made in the investigations being carried out at the Equine Research Station at Balaton Lodge and Lanwades Park, Newmarket, into infertility, parasitology and diseases of foalhood. During the ten months, the Trust has granted a number of research fellowships to individual workers who wished to continue investigations of an independent nature, and helped some veterinary surgeons to go abroad to widen their experience. Six county committees of the Trust have been formed and eleven others are in the process of being established.

Zoological Society of Bengal: New Journal

Zoologists will be interested in the appearance of vol. 1, No. 1 of the *Proceedings of the Zoological Society of Bengal*, which, it is announced, will be published twice yearly and will contain the results of original research in the various branches of zoology. The first number (obtainable from the Society at 35 Ballygunge Circular Road, Calcutta; price 5 *Rs.* or 10*s.*) comprises 78 pages and 4 plates; and it contains eight papers covering a wide field, contributed mainly by the Department of Zoology of the University of Calcutta. S. P. R. Chaudhuri and I. Bose give an account of meiosis in diploid and tetraploid

spermatocytes of the grasshopper *Attractomorpha* sp., while meiosis and chiasma formation in another grasshopper, *Tristria pulvinata*, is the subject of a paper by M. K. Dutt. In a study of the scales in *Glossogobuis giuris*, S. Mookerjee shows that the ctenoid condition is an advance on the cycloid which occurs earlier in development. The bionomics and reproduction of another fish, *Ophicephalus striatus*, are discussed by H. K. Mookerjee, D. N. Ganguly and R. N. Bhattacharya, and R. P. Dhar contributes a hæmatological note on a closely allied species. Some myxosporidians parasitic in fishes are described by M. Chakravarty and S. P. Basu. Termite control with various insecticides tried out in the field is the subject of an investigation by D. Mukerji and P. K. Mitra, and the final paper, concerning the development of the vertebral column in *Alligator mississippiensis*, is by H. K. Mookerjee and R. N. Bhattacharya. Text and figures are clearly printed on good art paper.

Preslia: Botanical Research in Czechoslovakia

THE Czechoslovak Botanical Society has just published a comprehensive issue (vols. 22 and 23, pp. 248) of its proceedings, *Preslia*, for the years 1943–47. The periodical, named after the brothers J. S. and K. B. Presl, who flourished in the first half of the last century, had been an annual publication for some time before the War, but nevertheless served as a repository for the results of botanical research in Czechoslovakia. The Society now has an active membership of more than two hundred, besides that of some twenty-nine (pre-war, thirty-seven) affiliated societies and naturalists' clubs. During the period under review it was mainly through these that botanists were able to continue working and publishing. The current issue of *Preslia* lists these contributions for the years 1939 to 1947 as well as describing (in English and Czech) the recent history of some of the affiliated institutions. Some institutes are still not in working order. Dr. I. Klášterský is held up with his work on the genus *Rosa*; Prof. J. Peklo lacks facilities for his phytopathological studies, and Prof. K. Domin cannot obtain the foreign literature he needs for comparative purposes. So far as botany is concerned, Slovakia appears to have suffered less than Bohemia, though Prof. B. Němec states that the Bratislava University Institute for Plant Physiology lacks microscopes and other equipment, and is without a proper library. A note in *Preslia* refers to the failure of the Botanical Society to obtain a grant from Unesco through the Association Internationale des Microbiologistes, and this is likely to delay further publication. In 1938 a group of botanists founded a journal, *Studia Botanica Cechoslovaka*. It survived until 1943, and hope is now expressed that it will resume publication under the editorship of Prof. S. Prát and Dr. I. Klášterský.

Toxicity of Certain Synthetic Organic Compounds to Insects

THIS subject is discussed in the *Canadian Journal of Research*, June 1948, in a paper divided into two parts. In Part 1 Messrs. A. W. A. Brown, D. B. W. Robinson, H. Hurtig and B. J. Werner record their results from testing the general toxicity of some 127 synthetic compounds when mixed in graded concentrations in the food of the larvæ of the housefly (*Musca domestica*), the confused flour beetle (*Tribolium confusum*), the Mediterranean flour moth (*Ephestia Kuhniella*) and adults of the granary weevil (*Sitophilus granaria*). Each compound was intimately mixed with the food medium in which each of the foregoing insects lives and feeds. The method of testing gives an overall measure of the contact, stomach, and fumigant action of each compound without distinction as to its mode of action. The most highly toxic substances were found to be 'Gammexane' (the gamma isomer of hexachlorocyclohexane) and chlordane (obtained by the distillation of technical chlordane). The toxicity of D.D.T. was, on an average, one half of that of these two compounds. In Part 2 Messrs. A. W. A. Brown, B. J. Werner and F. E. Park record the results of their experiments regarding the direct toxicity of 91 compounds against the nymphs of the German cockroach (*Blatella germanica*) and of the large milk-weed bug (*Oncopeltis fasciatus*), continuously reared in the laboratory on seeds of *Asclepias syriaca*, and also adults of the confused flour beetle (*Tribolium confusum*). The compounds used were dissolved in graded concentrations in a benzine–kerosene mixture and sprayed on the insects confined in a cylindrical glass spraying tower 29 in. high. Compressed air was applied to an atomizer at a uniform pressure of 23 cm. mercury. Taking the results with the three species of insects as a whole, the highest contact toxicity was shown by 'Gammexane' and chlordane. Dinitro-*o*-cresol and dinitrocyclohexylphenol were next in order of effectiveness. The results described in the two parts of this paper are based on tests carried out at the Experimental Station, Suffield, Alberta.

International Veterinary Congress

THE Fourteenth International Veterinary Congress will take place in London during August 8–13, 1949, and the meetings will be held at the Central Hall, Westminster, and in Church House, Westminster, S.W.1. The Duke of Gloucester, who is the president of the Royal Veterinary College and Hospital of London, hopes to be able to open the Congress. As it is considered that the present world food situation is the most important scientific and practical question of the day, the programme of the Congress has been based on this theme. Every morning there will be a plenary session at which a paper will be presented by a leading authority on the veterinary profession's contribution to some aspect of world food production. Sectional meetings will be held in the afternoons, and the programme for these is designed to cover a wide range of subjects. The executive committee has been appointed as follows: *President*, Sir Daniel Cabot; *vice-president*, Prof. J. B. Buxton; *honorary secretary*, Dr. W. R. Wooldridge; *honorary treasurer*, Mr. G. N. Gould; *general secretary*, Mr. W. G. R. Oates. An exhibition of the latest instruments, appliances, drugs, disinfectants, books, etc., will be arranged near to the Central Hall. Social functions have been arranged for the evening of August 7, and during the week of August 15–20 excursions will be made to places and establishments of veterinary interest. Official invitations to the Congress have been issued by the Government of Great Britain to foreign, Commonwealth and Colonial Governments. Representation has been invited not only from government veterinary departments, but also from universities, veterinary schools and other interested bodies in every country. Persons desirous of attending the Congress should apply as early as possible, and all inquiries should be addressed to the Organising Secretary, Fourteenth International Veterinary Congress, 10 Red Lion Square, London, W.C.1.

Fourth Empire Mining and Metallurgical Congress

A NOTE on the coming Fourth Empire Mining and Metallurgical Congress has already been published in *Nature* (October 16, p. 606). A second circular on this Congress is now available, and in it details are to be found relating to the inaugural programme in London for July 9–12 and to the technical sessions to be held in Oxford during July 13–17. In Oxford the main subjects for discussion will be: mineral resources of the Commonwealth; modern methods of prospecting; physiological and psychological effects of heat and humidity on workers in deep mines and in metallurgical works; petroleum —with special reference to the world oil position, oil-well drilling practice and its application to petroleum exploration; coal—with special reference to resources of the Commonwealth, the characteristics of Empire coals and modern coal-mining practice in Great Britain; present-day trends in mineral dressing; and metallurgy and metallurgical industries. Also in this circular full details are given of the excursions during July 18–23. The programme consists of visits, based on Cardiff, Cornwall, Edinburgh, Manchester, Newcastle-upon-Tyne, Sheffield and Stratford-upon-Avon, which will be made to collieries, iron and steel works, hydro-electric schemes, shipbuilding yards and other places of technical interest, together with a number of excursions of historical and general interest. Further information may be obtained on application to the Joint General Secretaries, Fourth Empire Mining and Metallurgical Congress, 436 Salisbury House, Finsbury Circus, London, E.C.2.

Applications of Ultrasonics

THE Acoustics Group of the Physical Society has arranged to hold a discussion meeting on the applications of ultrasonics at th Imperial College, London, S.W.7, at 2.15 p.m. on February 18; Mr. G. Bradfield will read a review paper and Mr. J. M. M. Pinkerton will outline the application of ultrasonics to the investigation of molecular structure. These papers will be followed by sixteen invited contributions covering the majority of present applications: other workers in supersonics who may wish to contribute should write to the Joint Honorary Secretaries of the Acoustics Group of the Physical Society, 1 Lowther Gardens, London, S.W.7.

Committee on Exports and Imports of Cattle Semen

THE Minister of Agriculture and Fisheries and the Secretary of State for Scotland have appointed a Committee with the following terms of reference: "To advise on the considerations which should govern the granting of licences for the export and import of cattle semen for the purposes of artificial insemination and on any other problems related thereto". The Committee is constituted as follows: Lord Oaksey (*chairman*), Col. S. E. Ashton, Sir John Barlow, Dr. J. Hammond, Mr. E. O. Jones, Mr. Alexander Keith, Prof. W. C. Miller, Mr. Duncan M. Stewart, Mr. W. R. Trehane and Mr. W. J. Wright. The secretary to the Committee is Mr. R. Harding Wynne of the Ministry of Agriculture and Fisheries, 14 Chester Terrace, Regent's Park, London, N.W.1.

Science Masters' Association: Scottish Branch

THE annual general meeting of the Scottish Branch of the Science Masters' Association will be held in St. Leonard's School, St. Andrews, during April 12–14, under the presidency of Sir James Irvine. The principal speakers will be Prof. John Read, Prof. A. D. Peacock, Dr. Freundlich and Dr. Steel. They are to give addresses on "Giant Molecules", "Darwinism Up-to-Date", "The Problem of Evolution in Astronomy" and "Tidal Power", respectively. Visits have been arranged to the works of the Cash Register Co., Guardbridge paper mills, the sugar beet factory at Cupar, and elsewhere. Publishers and scientific instrument makers are also taking part.

Announcements

SIR WALLACE AKERS, a director of Imperial Chemical Industries, Ltd., has been appointed a trustee of the National Gallery.

IT is announced from the University of London that Mr. Ronald King has been appointed to the University readership in physics tenable at University College as from January 1. The following doctorates have been conferred: *D.Sc.*, Mr. Hans Grüneberg (reader at University College), Mr. S. E. Jacobs (Imperial College), Mr. R. C. Jordan (Imperial College); *D.Sc.* (*Econ.*), Mr. S. M. Dhumé (London School of Economics).

A NEW open scholarship, worth up to £1,000, is being offered by the Textile Institute, and applications are invited both from those already engaged in the textile industry and from those still at school who propose to study textile technology. The scholarship is intended to provide facilities for a three years course of study in textile technology to an advanced stage and for industrial experience in Great Britain and abroad. Details and application forms are available from the General Secretary, Textile Institute, 16 St. Mary's Parsonage, Manchester, 3.

THE Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland propose to award, for the academic year beginning October 1, 1949, a limited number of postgraduate scholarships in husbandry, agricultural economics, statistics, and agricultural and dairy engineering. The closing date for applications is May 15, 1949. Further particulars may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 1/4 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh, 1, according to the country of residence. Applicants resident in Northern Ireland should apply to the Ministry of Agriculture and Fisheries, London, at the above address.

A CONFERENCE on Mental Health will take place at Seymour Hall, Seymour Place, London, W.1, on March 17 and 18, 1949. Applications for tickets and all correspondence should be addressed to the Conference Secretary, 39 Queen Anne Street, London, W.1.

THE date of the Fifth International Congress of Comparative Pathology in Istanbul (see *Nature*, November 27, p. 844) has been put forward to April 22–29, 1949.

REFERRING to his article on "Ancient Arts and Modern Parodies" in *Nature* of January 22, p. 146, Mr. William Fagg states that the last sentence of the second paragraph should read, "Less easy to explain is the omission of the truly primitive sculpture of Borneo . . ."

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Elementary Particles and the Principle of Reciprocity

THE discovery of different kinds of mesons with rest-masses spreading over a considerable range has brought about a fundamental change in the aspect of the problem of elementary particles. It looks as if there exists a great many, possibly an infinite number of particles with different rest-masses, most of them being unstable, while a few have a long lifetime. So long as one had to deal only with a small number of particles, the electron, nucleon (proton–neutron), and Yukawa's meson, it was appropriate to treat each of them separately and to describe them by wave equations constructed according to the more or less known properties (rest-mass, spin) of the particles. This procedure has now become inadequate; one has to face the problem of the interrelation of the particles and in particular of their rest-masses. The safest course to take would, of course, be to wait until enough experimental material has been accumulated for building a reliable theory on it. Yet I think that preliminary work can be done now, namely, a discussion of the type of theory which could deal with the situation.

Each kind of particle is associated with a field (photon-Maxwell field, electron-Dirac field, meson-Yukawa field, etc.), satisfying a set of wave equations. Instead of these equations one can use the corresponding Lagrangian density L, the form of which depends on the spin, the rest-mass being the essential characteristic constant. If L is known, the field equations can be established; the solution of these are the wave functions ψ which determine the behaviour of the particles.

While the determination of ψ from a given L is the central problem of our present quantum mechanics, the new experimental situation demands a change of attitude: L itself becomes the unknown function. One needs, therefore, a general principle which determines the possible L's in regard to their spin-structure and rest-mass constant.

Some years ago, I suggested a very general principle, called the postulate of reciprocity, which states that the ultimate laws of physics should be symmetric in space-time x^k and momentum energy p_k ($k = 1, 2, 3, 4$). The evidence for this hypothesis is slender; it consists in the formal fact that this symmetry appears in the basic law of quantum mechanics, the commutation rule $x^k p_l - p_l x^k = i\hbar\delta_{kl}$, and in some other important concepts like the angular momentum. Further, many facts indicate the existence of a universal length a; then Planck's constant splits up into a product, $\hbar = ab$, where b is a universal momentum (or, for $c = 1$, an energy, or a mass). Finally, nuclear physics presents systems where neither a spatial description (allocation of positions to nucleons) nor a purely momental representation is adequate, but a combination of the two.

However, applied to present quantum mechanics (ψ-functions), this principle has not proved to be fertile. There is in Nature no obvious symmetry of the kind postulated. One has to go one step deeper and apply the postulate to the L-functions described above.

Before this could be done, a considerable amount of work had to be carried out in developing the most general field theories possible in such a way that the clumsiness of the usual formalism is avoided. This has been done by my collaborator, Dr. H. S. Green, who will explain his new methods of field quantization in another letter. Here a few points suffice.

Instead of the wave function ψ, there is used the statistical matrix ρ which for pure states reduces to $\psi\psi^*$ but represents also 'mixtures'. The most general Lagrangian of a field can then be written $L = F(p_k, p_k')\rho$, where F is a function of two sets of four variables; both these represent the momentum, but p_k operates on ρ from the left, p_k' from the right. Without going into details, it is only necessary to state Green's extremely simple result, that the field equations can be written in the form

$$F(p_k, p_k)\,\rho = 0. \qquad (1)$$

Hence the function (Fp_k, p_k), or shortly $F(p)$, is characteristic of a given type of field.

I now propose to apply the principle of reciprocity to this function: only self-reciprocal functions F can be used for describing particles. This in combination with the principle of relativity is, in fact, a powerful instrument for obtaining particles with definite rest-masses. I shall indicate this for the example of scalar fields (spin zero).

A simple way of finding all self-reciprocal scalars is to determine the eigenfunctions of the operator $x^k x_k + p^k p_k$, where the co-ordinates and momenta are measured in the units a and b respectively ($ab = \hbar$). It is easy to see that the relativistic invariant eigenfunctions have the form

$$F(p) = f(P)\; e^{-P/2}, \qquad (2)$$

where $f(P)$ are Laguerre polynomials of the argument $P = p_k p^k$. The simplest of these belonging to the eigenvalues 0, 1, 2 . . . are:

$$f_0 = 1, \quad f_1 = P - 2, \quad f_2 = P^2 - 6P + 6. \qquad (3)$$

Since the exponential factor in (2) never vanishes, the field equations (1) reduce to

$$f(p)\rho = 0. \qquad (4)$$

By factorizing the polynomial $f(p)$, one sees that (4) can be satisfied by plane waves with momentum-energy $p^0{}_k$ if $P^0 = p^0{}_k p^{0k}$ is one of the roots of $f(x) = 0$. These roots are positive numbers easily obtained from (3); for example, for f_1, $x_1 = 2$; for f_2, $x_2^{(1)} = 3 + \sqrt{3}$, $x_2^{(2)} = 3 - \sqrt{3}$, etc. If x_r is one of these, one has a wave which satisfies

$$(p_k p^k - x_r)\,\psi = 0; \qquad (5)$$

hence the conclusion suggests itself that $\sqrt{x_r}$ is a possible rest-mass.

To show this rigorously one has to investigate whether it is possible to formulate the quantized field theory for any such function in such a way that the total energy and momentum of the field appear in the form

$$P_k = \sum_r n_r p^0{}_k{}^{(r)}, \quad p^{0(r)}\, p^0{}_k{}^{(r)k} = x_r, \qquad (6)$$

where the n_r are operators with integral eigenvalues. This has been proved for the most general Lagrangian by Green (see the following letter).

One has therefore already for scalar fields an infinite number of different particles with numerical rest-masses; the lowest are

$$\sqrt{2} = 1{\cdot}414,\ \sqrt{3+\sqrt{3}} = 2{\cdot}175,\ \sqrt{3-\sqrt{3}} = 1{\cdot}126, \ldots$$

and their ratios correspond roughly to some experimental results on mesons. But it would be premature to discuss this question.

Lagrangians for particles with spin can be found in a similar way. For example, for spin $\frac{1}{2}$ one obtains, as the simplest self-reciprocal F, Dirac's expression with an exponential factor similar to that in (2).

One can regard the theory suggested here also from quite another angle, namely, as a rational generalization of relativity. Ordinary relativity is based on the invariance of the 4-dimensional distance, or its square $R = x^k x_k$. Can one really define distance of two particles in sub-atomic dimensions independently of their velocity? This seems to me not evident at all.

The theory proposed here for scalar fields is equivalent to demanding as a fundamental invariant the sum $R + P = x^k x_k + p^k p_k$. For macroscopic bodies, where the p_k are extremely small in our units, this reduces to Einstein's $R = x^k x_k$; on the other hand, for the interior of nuclei, spatial dimensions are negligible and the generalized distance reduces to $P = p^k p_k$. In the general case the eigenvalues of $R + P$ are integers which indicate a kind of discontinuous structure of the x- or the p-space, while the eigenfunctions F determine the dynamical laws. For spin $\frac{1}{2}$ one has to define the distance by taking the root of R and P with the help of properly chosen Dirac matrices.

It remains to consider the problem of interaction. So far as we can see at present, the postulate of reciprocity in conjunction with Green's field theory leads to a rational approach to this problem.

Whatever the success or failure of the special hypothesis suggested here, I am convinced that the quantum theory of particles has to solve the problem of determining Green's F-functions from some general principle.

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Nov. 3.

Quantized Field Theories and the Principle of Reciprocity

THE quantum theory of wave fields (reviewed by Pauli[1] in 1941) shows it is possible, starting from a known Lagrangian function L, to calculate the charge-current vector, the energy-energy flux tensor, and the angular momentum tensor for any wave field, and further how to quantize the field in such a way that the charge, energy and momentum of the field are expressed as integral multiples of some elementary units which are associated with the constituent particles of the field. The theory has recently been extended by Chang[2] and de Wet[3] to a more general type of Lagrangian, involving any number of space and time derivatives of the wave vector; the calculations of these authors are, however, so complicated that it is difficult to see how they could be applied, even if any specific application were envisaged, and besides they do not fully satisfy the requirements of relativity.

There is now little doubt that the existence of mesons with several different masses requires a wave equation of the type

$$F(P)\psi = 0, \quad P = p_k p^k = E^2 - p^2, \tag{1}$$

where E is the energy operator $i\hbar \frac{\partial}{\partial t}$, and p the momentum operator $-i\hbar \frac{\partial}{\partial x}$, the masses of the different particles being obtained as the roots of the equation $F(m^2) = 0$. (In equation 1 and elsewhere, a repeated suffix (k) is summed from 1 to 4.)

As Prof. Born has proposed, the possible functions F may be determined uniquely by the principle of reciprocity. For the quantization of wave fields described by equations such as (1), the technique of field theory has to be considerably refined. A Lagrangian operator of the form

$$L = F(p_k, p_l')\rho, \; p_k = i\hbar \frac{\partial}{\partial x^k}, \; p_k' = -i\hbar \frac{\partial}{\partial x^{k'}}, \tag{2}$$

may be defined, where ρ is the relativistic statistical operator, which is in the co-ordinate representation a function of two complete sets of co-ordinate variables $x^k \equiv (x,t)$ and $x^{k'}$. The operator ρ must be distinguished from the true density operator, to be defined later. The field equations, of which (1) is typical, are then

$$\begin{aligned} F(p_k', p_l')\rho &= (F + \pi_k G^k)\,\rho = 0, \; \pi_k = p_k' - p_k; \\ F(p_k, p_l)\rho &= (F + \pi_k' G^{k'})\,\rho = 0, \; \pi_{k'} = p_k - p_k', \end{aligned} \tag{3}$$

which serve also to define G^k and $G^{k'}$. The equations of continuity, conservation of energy, energy transport, . . ., are obtained from them simply by multiplying the first by $1, p_k, p_k p^k, \ldots$, and the second by $1, p_k', p_k' p^{k'}, \ldots$, and subtracting, thus:

$$\begin{aligned} \pi_k (G^k + G^{k'})\rho &= 0, \\ \pi_k (F\delta_l^k - G^k p_l - G^{k'} p_l')\rho &= 0, \end{aligned} \tag{4}$$

where $R^k = \frac{1}{2}(G^k + G^{k'})\rho$ is interpreted as the density-flux vector, and $L_l^k = (F\delta_l^k - G^k p_l - G^{k'} p_l')\rho$ as the canonical energy flux tensor. It can be seen, therefore, that R^4 is the true density operator, and that the Hamiltonian energy-momentum vector

$$P_k = \int \tfrac{1}{2}(p_k + p_k') R^4 d\Omega \tag{5}$$

differs in the integrand from L_k^4 only by a space divergence which vanishes on integration over the real space Ω.

The commutation rule has the very simple form

$$\zeta_i R^4 \pm R^4 \zeta_i = \zeta_i, \tag{6}$$

where ζ_i is a creation operator for a particle with mass m_i, and the positive or negative sign is taken according as the particle obeys Fermi or Bose statistics. If ρ is expressed in the form

$$\rho = \sum_{ij} \psi_i(x_k)\, \psi_j^*(x_l'), \tag{7}$$

the rule (6) reduces to

$$\tfrac{1}{2}(G_4 + G_4')\,[\psi_i(x_k), \psi_j^*(x_l')] = \delta(x - x')\delta_{ij} \; (t' = t). \tag{8}$$

From this one can easily show that the field consists of particles with different but definite masses, to each of which can be assigned a definite energy and momentum. One can show further that the energy-momentum operator P_k has the property of the differential operator in commutation with ψ_i, so that the transition to quantum mechanics can now be completed by expressing the field equations in operational form.

This theory is quite general. When applied to Born's self-reciprocal Lagrangians, one obtains immediately the picture of a single quantized wave field in which particles with different rest-masses co-exist without interaction. Particles belonging to different

eigenfunctions F may, however, interact directly, and it appears to be possible to determine the form of interaction uniquely from the principle of reciprocity, restricted only by the requirements of the conservation of charge, momentum and spin (angular momentum) which are consequences of the theory. It can therefore be hoped that the adoption of the principle of reciprocity may lead to a purely deductive theory of the sub-atomic particles in agreement with the experimental facts.

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Nov. 3.

[1] Pauli, W., *Rev. Mod. Phys.*, **13**, 203 (1941).
[2] Chang, T. S., *Proc. Camb. Phil. Soc.*, **42**, 132 (1946); **44**, 76 (1948).
[3] de Wet, J., *Proc. Camb. Phil. Soc.*, **44**, 546 (1948).

Low-Temperature Ultra-Violet Absorption Spectra of Biologically Important Compounds

The work of Holiday[1] on the ultra-violet absorption spectra of amino-acids at room temperatures, and of Caspersson[2] and others on the absorption characteristics of biological material, have made clear the importance of this physical approach to the greater understanding of the living cell. It has also been known for a long time that the absorption and fluorescence spectra of solids may sharpen as the temperature is lowered; in the inorganic field this effect has frequently been used in the interpretation of the energy states of ions. The work described in this note is the first step in an investigation of the possibilities of low-temperature microspectrography of biological material as an aid to distinguishing between various important compounds.

Since the work to be described was begun, Loofbourow[3] and others have given evidence concerning the narrowing of the ultra-violet absorption spectra of thymine and tryptophan. Below are given detailed results on the absorption spectra of some purines, pyrimidines and amino-acids at 90° K.

Absorption peaks of sublimed films

Compound	Absorption peaks at room temperature	Absorption peaks at 90° K.
Thymine	2827, 2763, 2709, 2653	2818, 2759, 2704, 2651, 2597, 2546
Uracil	2658, 2543	2859, 2796, 2723, 2650, 2558
Adenine	2868, 2764, 2663	2880, 2829, 2771, 2720, 2669
Guanine	2935, 2775, 2690	2918, 2836, 2774, 2719, 2666
Tryptophan	2998, 2880, 2810	2993, 2931, 2869, 2807, 2739, 2680
Phenylalanine	2693, 2655, 2593, 2535, 2482, 2427, 2222	2691, 2651, 2625, 2589, 2529, 2480, 2423, 2221, 2190

The low-temperature apparatus used was a glass-metal Dewar vessel, the inner metal portion of which consisted essentially of a 'fernico' tube closed at the lower end by a copper block. The 'fernico' alloy seals readily to glass, forming a seal which withstands the thermal strains set up by the cooling liquids used in the experiments. We are indebted to the director of research of the British Thomson-Houston Co., Ltd., for provision of the glass-metal seal. Cells suitable for the examination either of films, or of solutions that form glasses at low temperatures, can be readily interchanged. The cells were designed so as to screw directly into the copper block, which is immediately in contact with the cooling liquid. This apparatus may be used for studies as low as 60° K. The temperature of the specimens was measured by means of a contact thermocouple. With liquid nitrogen in the Dewar vessel, the temperature of films in the holder was 90° K.

A hydrogen discharge lamp was used as a source of continuous radiation, and films of purines, pyrimidines and amino-acids were prepared by sublimation under reduced pressure on to quartz coverslips. The infra-red spectra of films sublimed on to rock salt plates are practically identical with the results obtained from suspension of the same compounds in liquid paraffin. The ultra-violet absorption spectra were photographed in a Hilger medium quartz spectrograph, moving the photographic plate in its own plane by means of a logarithmic cam: this device, due to Holiday[4], shows up weak absorption bands to great advantage.

Fig. 1. Thymine: room temperature

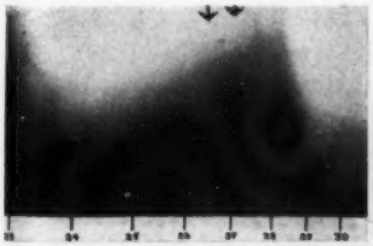


Fig. 2. Thymine: 90° K.

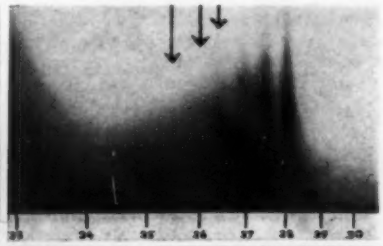


Fig. 3. Adenine: 90° K.

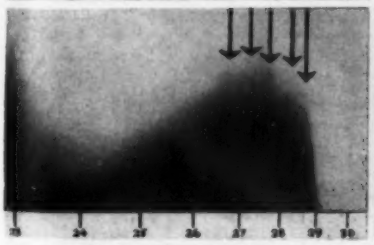
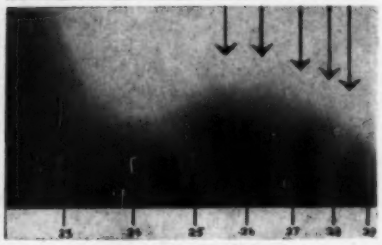


Fig. 4. Uracil: 90° K.



Figs. 2 and 4 show that although there is some structure in the absorption spectrum of uracil at 90° K., the sharpness of the thymine spectrum is much more marked. From a cytological point of view this difference holds interesting possibilities, since thymine is a constituent base of desoxyribosenucleic acid but not of ribosenucleic acid, and gives much sharper absorption peaks than the other bases (guanine, adenine, uracil) so far studied. These results, together with other work now in progress on tissue slices, indicate the importance of further ab-

sorption and microspectrographical studies at low temperatures, both on individual compounds and on biological specimens.

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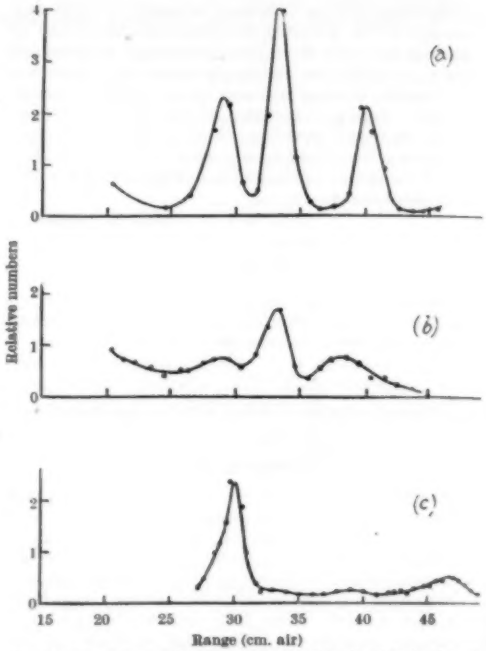
Disintegration of Separated Isotopes of Magnesium by Deuterons

IN a recent study of the transmutation of a number of elements by deuterons[1], the emission of three groups of protons from magnesium under deuteron bombardment was reported. These groups were assigned to particular isotopes by arguments based chiefly on the value of the energy released in similar reactions with other elements and on differences between the excitation functions of the groups. We have now been able to bombard separated isotopes, and the accompanying graph shows the proton groups observed from targets of magnesium-24, -25 and -26 deposited on stainless steel. The deuteron energy was 930 keV. as in the earlier experiments, and the protons were observed at right-angles to the incident beam. The three targets for which the results are shown in the figure were cut from larger areas on which the magnesium was deposited; but since the deposits were not uniform, the target thicknesses could not be accurately estimated. In the case of the magnesium-24 target, observation of the width of a $(p\gamma)$ resonance-level suggested an equivalent thickness of about 10 keV.; the thickness of the magnesium-25 and -26 targets was unknown, and the relative intensities of the groups shown in the graph are therefore unlikely to be those which would be obtained from targets in the normal isotopic ratio of thickness.

The earlier interpretation of the proton groups now has to be revised and extended as follows:

Magnesium-24: The groups observed (Fig. *a*) are similar in range and relative intensity to those found from ordinary magnesium targets. The *Q*-value of 5·03 MeV. previously given[1] for the reaction $Mg^{24}(dp)Mg^{25}$ is therefore confirmed, and the other two groups shown in Fig. *a* indicate excited states in magnesium-25 at 0·58 and 0·98 MeV.

Magnesium-25: We believe that the groups observed (Fig. *b*) from this target are due to contamination by magnesium-24, since they are the same both in range and relative intensity, within the limits of error of the experiment, as those observed from the magnesium-24 target. This has been established by careful counting, under conditions of good geometry and low bias, for several different magnesium-25 targets. There is no evidence for the previous assignment of the 35-cm. proton group to the transmutation $Mg^{25}(dp)Mg^{26*}$, although a small group of this range from magnesium-25 would be obscured by the contamination groups from magnesium-24. The main reason for originally ascribing the 35-cm. group to the transmutation of magnesium-25 was the fact that its excitation function differed



Number-range curves for protons emitted in the bombardment of targets of separated isotopes of magnesium by deuterons: (*a*) Mg^{24}; (*b*) Mg^{25}; (*c*) Mg^{26}. The target thicknesses do not necessarily correspond to the normal isotopic ratio

strikingly from that of the 32- and 42-cm. groups[1]. Two of us (C. A. W. and C. D. C., unpublished) have since shown that this difference may be explained by variations in the angular distribution of the emitted particles with bombarding energy.

Magnesium-26: The group of protons of range 32 cm. (Fig. *c*) found from the separated target would not have been resolved in the experiments with ordinary magnesium from the strong group of similar range from magnesium-24. The new group gives a *Q*-value of $4·21 \pm 0·1$ MeV. for the reaction $Mg^{26}(dp)Mg^{27}$ instead of the value previously quoted of 4·05 MeV. The group of protons at 48 cm. appears on blank targets and could be due to carbon contamination.

The separated targets have also been used to confirm the reaction $Mg^{26}(d\alpha)Na^{24}$ [1]. The 15-hr. activity of sodium-24 was easily observed and followed from the magnesium-26 target after deuteron bombardment, while the activity of this period from similarly bombarded targets of magnesium-24 and -25 was at least ten times smaller.

We are very grateful to Sir John Cockcroft and to Dr. W. D. Allen and members of his group at the Atomic Energy Research Establishment, Harwell, who provided the separated targets used in this work.

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Magnetic Moments of Deuterium-2, Lithium-7 and Fluorine-19

THE exceptionally small natural line-widths obtainable with the magnetic resonance absorption method[1,2] or nuclear induction method[3,4] makes these methods suitable for precision measurements of nuclear magnetic moments. We have constructed an apparatus for this purpose, and have paid special attention to the problem of getting a magnetic field which fulfils the rather extreme requirements of field homogeneity. In this case it was also important that the homogeneity was of such an extension that two different probes could be investigated at the same time on two different places in the field. The pole-pieces of the magnet were 30 cm. in diameter, separated by spacers 4·2 cm. apart. Both the pole-pieces and the spacers were polished optically flat, so that the air gap was the same within 1 μ everywhere.

For the detection of the resonances we have used the balance method first proposed and used by Purcell, Torrey and Pound[1]. The field was carefully mapped by inserting a water probe in the field and observing the difference in resonance frequency for protons in different places. We have been able to find two extremely homogeneous places in the field where resonance absorption simultaneously can be studied, one for protons and the other for the unknown magnetic moment. The homogeneity was such that the line-widths in the two places were about 0·1 gauss. The very small difference in magnetic field between the two places (2 in 10^8) was determined by observing simultaneously the proton resonances in both places.

The signals from the two high-frequency bridges were fed to a double-beam oscillograph, and the two frequencies were adjusted to get the two signals to coincide. Any displacement between the signals on the screen was corrected for by photographing the screen. The total amplitude of sweep on the screen usually corresponded to about 0·3 gauss and was synchronized with the modulation of the magnetic field.

Every magnetic moment has been measured several times at different field-strengths. The two frequencies to be compared were measured by a General Radio Frequency Standard (Type 1100-*A*, form 664-*A*), which permits an accuracy of 1 in 10^6 in the frequency determination. Our determinations of the nuclear magnetic moments of D^2, Li^7 and F^{19} are summarized in Tables 1, 2 and 3 (the diamagnetic correction is not included).

All moments are expressed in the proton moment as a unit. For deuterium-2 we obtained $\mu_D/\mu_P = 0{\cdot}3070183 \pm 0{\cdot}0000015$; for lithium-7 $\mu_{Li^7}/\mu_P = 1{\cdot}165833 \pm 0{\cdot}000050$; and for fluorine-19 $\mu_{F^{19}}/\mu_P = 0{\cdot}940934 \pm 0{\cdot}000015$.

All our individual measured values fall inside the limits given here. Only the deuteron moment has been determined before by this method, and our value agrees within the limits of error with the determination by Bitter *et al.*[5] ($\mu_D/\mu_P = 0{\cdot}307021 \pm 0{\cdot}000005$), but falls a little outside the value obtained by Bloch *et al.*[6] ($0{\cdot}3070126 \pm 0{\cdot}0000020$).

The μ-values of lithium-7 and fluorine-19 have not previously been measured accurately by the new method. The values obtained with Rabi's method[7] ($\mu_{Li^7}/\mu_P = 1{\cdot}16622 \pm 0{\cdot}00090$ and $\mu_{F^{19}}/\mu_P = 0{\cdot}9410 \pm 0{\cdot}0013$) are given with considerably higher limits of error, but are consistent with our new values.

A more detailed report of this work will appear in *Arkiv för Mat., Ast. och Fysik.* This investigation has been sponsored by the Swedish Natural Science Research Council.

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Table 1

Magnetic field (in gauss)	ν_D (in Mc.)	ν_P (in Mc.)	$\frac{\mu_D}{\mu_P} = \frac{2\nu_D}{\nu_P}$
about 3530	2·357340	15·356360	0·3070185
,, 5250	3·500000	22·800000	0·3070176
,, 5250	3·500000	22·800000	0·3070176
,, 5700	3·801091	24·761325	0·3070183
,, 5700	3·801073	24·761120	0·3070195

Mean value, 0·3070183; maximum error, ± 0·0000015.

Table 2

Magnetic field (in gauss)	ν_{Li^7} (in Mc.)	ν_P (in Mc.)	$\frac{\mu_{Li^7}}{\mu_P} = \frac{3\nu_{Li^7}}{\nu_P}$
about 5800	9·7249	25·0250	1·16583
,, 5900	9·7778	25·1615	1·16581
,, 5900	9·7765	25·1575	1·16584
,, 5900	9·7776	25·1604	1·16583
,, 6810	11·2893	29·0504	1·16583
,, 6810	11·2896	29·0501	1·16588

Mean value, 1·16584; maximum error, ± 0·00004.

Table 3

Magnetic field (in gauss)	$\nu_{F^{19}}$ (in Mc.)	ν_P (in Mc.)	$\frac{\mu_{F^{19}}}{\mu_P} = \frac{\nu_{F^{19}}}{\nu_P}$
about 4600	18·411164	19·566660	0·940946
,, 4600	18·414476	19·570116	0·940949
,, 4500	18·410958	19·566764	0·940930
,, 4600	18·410966	19·566828	0·940927
,, 4600	18·410985	19·566736	0·940933
,, 5710	22·975250	24·417890	0·940919
,, 5710	22·975350	24·417600	0·940934

Mean value, 0·940934; maximum error, ± 0·000015.

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Slow-Neutron Capture in Helium

THE cross-section for capture of thermal neutrons in helium according to the reaction

$$He^3 + n \rightarrow H^3 + p + 750 \text{ keV}.$$

has been measured relative to the similar reaction in nitrogen for which the cross-section is given as 1·7 barns[1]:

$$N^{14} + n \rightarrow C^{14} + p + 600 \text{ keV}.$$

Cloud-chamber photographs of the helium reaction by slow neutrons have recently been obtained by Hughes and Eggler[2], who found an energy release of 740 keV. The cross-section for such a reaction might be expected to be large.

Briefly, the method was to compare the counting-rates produced in a gridded ionization chamber filled alternately with atmospheric helium, containing $1{\cdot}20 \times 10^{-6}$ parts[3] of helium-3, and argon, containing a small known admixture of nitrogen, irradiated in a thermal neutron flux of approximately

10^6 neutrons/cm.^{2}/sec. at the thermal column of the Harwell low-energy pile (G.L.E.E.P.).

The helium used contained 2 per cent of nitrogen, which was removed by passing the gas over a large quantity of activated absorption charcoal. British Oxygen Co. 'oxygen-free' argon was used, containing about 0·3 per cent of nitrogen.

Counts were taken on a differential pulse-height analyser, and a well-resolved energy peak was obtained in each case. In order to eliminate effects due to fast neutron recoils in the abundant helium-4, counts were taken with and without cadmium surrounding the chamber in the helium runs. Counts with cadmium in the argon runs were negligible.

If N_1 is the total counting-rate due to the thermal (n,p) reaction in helium, and N_2 the total counting-rate due to the reaction in nitrogen present in the argon, then, under otherwise identical conditions,

$$\frac{N_1}{N_2} = \frac{\sigma_1 p_1 C_1}{2\sigma_2 p_2 C_2},$$

where σ_1 is the cross-section for the He^3 reaction, p_1 is the total pressure of helium in the chamber, C_1 is the concentration of helium-3 in atmospheric helium; while the corresponding quantities with subscript 2 refer to the N^{14} reaction in the argon, and the factor 2 allows for the fact that nitrogen is diatomic.

The ratio N_1/N_2 in a single such measurement could be obtained to an accuracy of about 2 per cent, the pressures p_1 and p_2 were measured on a calibrated pressure gauge, and the nitrogen content C_2 was known to about 6 per cent from mass spectrometer measurements and has been checked by other means. p_1 was made approximately four times p_2 in order that the proton ranges should be roughly equal in the two fillings.

From several separate determinations, a mean value for the cross-section was found to be

$$\sigma_{He^3} = (3{,}700 \pm 250) \times 10^{-24} \text{ cm.}^2.$$

This figure is given relative to 1·7 barns for the cross-section of N^{14} and $1{\cdot}20 \times 10^{-6}$ for the helium-3 content of atmospheric helium.

It is believed that all nitrogen was removed from the helium in these experiments, and indeed mass spectrometer measurements have set an upper limit of 10^{-4} parts to the nitrogen content. If this amount were, in fact, present, the above cross-section would be too high by some 6 per cent, which is within the error of the measurement.

In conclusion, we wish to thank Prof. F. E. Simon of the Clarendon Laboratory for lending us a cylinder of atmospheric helium, and Mr. G. H. Palmer for making the mass spectrometer analyses.

A complete account of this work will be given later.

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Nov. 1.

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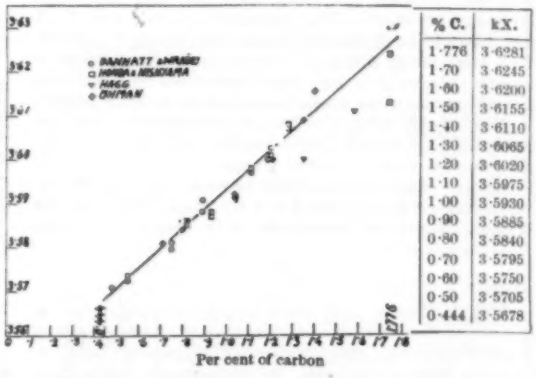
Lattice Spacing of Retained Austenite in Iron–Carbon Alloys

It is generally accepted that the lattice parameter of retained austenite in quenched iron–carbon alloys increases continuously and linearly with the increase of carbon content. So far, however, the presence of retained austenite has only been recognized when the iron–carbon alloy contains more than 0·6 per cent of carbon[1].

The assumption put forward by me[2] that the gamma solid solution in iron–carbon alloys is composed of pseudo-phases called γG, γS, γE, the amounts of which depend on the carbon content of the particular alloy, makes it possible to assume the existence of retained austenite in quenched alloys containing even less than 0·6 but more than 0·444 per cent of carbon. The examination of alloys in this composition range justifies the assumption.

An accurate measurement, for example, by means of the combined substance method[3] applied to X-ray films, taken from various iron–carbon alloys in quenched condition, confirms the continuous change of spacing of retained austenite to the extent that its regularity enables the determination of the carbon content of a particular alloy to be made.



% C.	kX.
1·776	3·6281
1·70	3·6245
1·60	3·6200
1·50	3·6155
1·40	3·6110
1·30	3·6065
1·20	3·6020
1·10	3·5975
1·00	3·5930
0·90	3·5885
0·80	3·5840
0·70	3·5795
0·60	3·5750
0·50	3·5705
0·444	3·5678

The accompanying graph shows the lattice spacings of retained austenite in iron–carbon alloys determined by various authors[1], including our own measurements[4]. The data shown, and many others collected during the experiments, suggest that there must be a theoretical value of lattice parameter for retained austenite in each of the quenched iron–carbon alloys containing carbon between 0·444 and 1·776 per cent. The most probable values of these can be represented by the straight line, and calculated from the formula:

$$a_\gamma = 3{\cdot}5678 + 0{\cdot}045\,(C - 0{\cdot}44) \text{ in kX.},$$

where 3·5678 in kX. is the most probable spacing of retained austenite in an iron–carbon alloy with 0·444 per cent of carbon, 0·045 is the value of the tangential function, that is, the constant increase in lattice parameter (0·0045 kX.) for 0·1 per cent of carbon, and C is the percentage of carbon in the alloy.

The figures thus obtained for the lattice spacing of retained austenite in a given iron–carbon alloy after quenching make it possible to decide that the measurement of the X-ray film was correct and that the heat-treatment was properly performed.

More detailed data connected with the description of the heat-treated iron–carbon alloys will be published elsewhere.

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Aug. 23.

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Deviation at Vertical Incidence in the Ionosphere

It was pointed out by Booker[1] ten years ago that even at vertical incidence the ordinary and extraordinary rays are deviated in the ionosphere, an effect that may be explained by the change in direction of the associated Poynting vectors. They are deviated in opposite directions from the vertical in the earth's magnetic meridian plane, and at their reflexion points they make angles with the vertical of D and $\tan^{-1}[\sin 2D/(3 - \cos 2D)]$, respectively, where D is the angle that the earth's field makes with the horizontal.

The latter deviation has a maximum value of 19° 28′ when $D = 35° 16'$; but under conditions when the earth's field is within, say, 30° of the vertical, the horizontal distance between the ordinary and extraordinary reflexion points can be as much as 50 km. for the F layer for frequencies close to the ordinary critical frequency. It follows that at times when large horizontal gradients exist in the ionosphere, the electron densities at the reflexion points for the ordinary and extraordinary critical frequencies can be markedly different.

Little mention of this possibility has so far been made in connexion with ionospheric sounding, but it appears that the effect can be large enough to influence the detailed interpretation of vertical incidence records. The deviation of the rays by the magnetic field, and by the horizontal gradient itself, may have an appreciable effect on the separation of the ordinary and extraordinary critical frequencies, and may account in part for the occasions when it differs markedly from its normal value. Alternatively, caution must be exercised, when using the separation as a measure of the gyro-frequency, in interpreting such variations as due to changes in the value of the earth's magnetic field.

In conclusion, we may remark in connexion with ionospheric observations made during an eclipse, when marked horizontal gradients of density must occur near the edges of the totality belt, that this effect may be of significance both with regard to the optimum siting of the sounding station, and to the conclusions drawn concerning the density changes caused by the eclipse.

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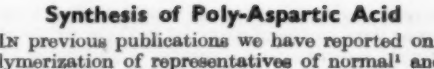
Synthesis of Poly-Aspartic Acid

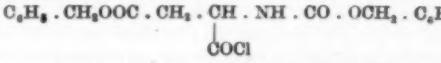
In previous publications we have reported on the polymerization of representatives of normal[1] and of basic[2] α-amino-acids. In the present communication the synthesis of poly-aspartic acid is dealt with as an example of the polymerization of a trifunctional acidic α-amino-acid.

A suitable monomer was found in the N-carboxy anhydride of *l*-aspartic acid β-benzyl ester,



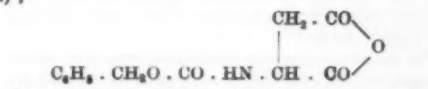
(I)

The reversible masking of the β-carboxyl group by the benzyl ester group ensures the exclusive participation of the α-carboxyl group of the aspartic acid in the peptide linking of the monomeric units. The monomer was obtained in the following way. The di-silver salt of N-carbobenzoxy *l*-aspartic acid (II)[3] gave with benzyl iodide in ether N-carbobenzoxy *l*-aspartic acid dibenzyl ester (III); partial hydrolysis by the calculated amount of potassium hydroxide in benzyl alcoholic solution affected the benzyl group attached to the α-carboxyl group only, and yielded the N-carbobenzoxy aspartic acid β-monobenzyl ester (IV). On suitable treatment of the latter with phosphorus pentachloride, the monomer I was obtained. The intermediate chloride (V)



(V)

was not isolated. The results of elementary analysis are consistent with formula I, but do not exclude the isomeric N-carbobenzoxy aspartic acid anhydride (VI)[4],

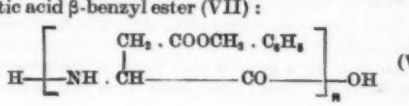


(VI)

the formation of which is also conceivable from (V) on loss of benzylchloride.

Some of the facts which prove that the substance obtained is different from (VI) and correctly represented by formula I are as follow: (i) the melting point found (111°, with evolution of carbon dioxide) is different from that of (VI) (124°)[4], and is depressed by the admixture of a preparation[4] of the latter; (ii) the ninhydrin colour reaction is positive; (iii) on heating, evolution of gas occurred, the loss of weight being in agreement with the calculated value of one mole carbon dioxide per mole of (I); the polymer obtained has the elementary composition to be anticipated in using a monomer of the formula I, and gives a strong biuret reaction.

In accordance with previous experience[3], monomer I was carefully dried in the polymerization vessel in high vacuum, first at room temperature and then at 60°, prior to the polymerization, which was carried out in high vacuum with stepwise raising of the temperature. At 109°, melting occurred with strong evolution of gas, causing a definite increase in pressure. On its decrease, the temperature was raised to 125° and the heating continued until evolution of gas appeared to have ceased entirely. The solid reaction product, giving a strong biuret reaction, is, according to analytical data, the poly-aspartic acid β-benzyl ester (VII):



(VII)

Van Slyke amino-nitrogen (manometric) determinations gave values of maximal 0·07 per cent amino-nitrogen, indicating an average chain-length of at least a hundred units and a molecular weight average of at least 20,000.

The corresponding poly-aspartic acid was obtained by treatment of a solution of the poly-ester (VII) in glacial acetic acid with phosphonium iodide in a stream of hydrogen gas. It is slightly soluble in hot water, soluble in dilute alkali.

We found that careful treatment of the poly-aspartic acid ester with normal alkali does not affect the peptide linkages; it appeared, therefore, feasible to obtain the acidic poly-α-amino-acids by eliminating suitably chosen (β- or γ-) ester groups from the respective poly-esters through hydrolysis with dilute alkali instead of the hydrolysis of these (benzyl) ester groups by phosphonium iodide. Experiments on these lines were started some time ago but were interrupted by conditions here.

A polymeric substance, the properties of which suggest peptide structure, was obtained from the product of the reaction of thionyl chloride on N-carbobenzoxy-*l*-aspartic acid (II). On heating this reaction product to 165°, melting occurred with evolution of gas and formation of a glassy mass which gave a positive biuret reaction, a negative reaction for diketopiperazines, and yielded the theoretical amount of aspartic acid on hydrolysis.

On prolonged heating of *l*-aspartic acid at 200° according to Schiff[5], a fraction not mentioned by him, insoluble in hot water, was obtained, giving a positive biuret reaction and having about 1 per cent of its total nitrogen in the form of amino-nitrogen. Hydrolysis of this product leads quantitatively to free aspartic acid. The structure of this polymer has not yet been clarified.

The experiments reported here are part of an investigation (cf. the thesis of one of us (A. B.) for the M.Sc. degree of this University) carried out in 1947. The conditions prevailing in Jerusalem during the present year [1948] have delayed the conclusion of this work.

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Aug. 20.

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Photosensitization by Vat Dyes

IT is well known that cellulose fabrics dyed with certain vat dyes disintegrate on exposure to light[1]. The experimental evidence suggests that a photosensitized oxidation of the cellulose is responsible. It is known that dyes do, in fact, photosensitize a number of reactions[2]; but no systematic survey of the field has been attempted, and the factors which determine the relative efficiencies of different dyes are not known. In a preliminary study of photosensitization, we have found that such dyes can initiate the autoxidation of tetralin, and the polymerization of styrene.

A tungsten filament projection lamp (1 kW.) was used as light source in the polymerization experiments, and a hot mercury arc (350 W.) in the autoxidation. In the latter case the light was filtered through 1 cm. of a 10 per cent solution of ferric alum in 2*N* sulphuric acid to remove light of wave-length less than 3600 A. The rates of reaction relative to pure tetralin and pure styrene are given in Table 1. The figures are approximate only, since many of the dyes fade, especially during the polymerization.

Table 1

Dye	Relative rate of oxidation pO_2 = 650 mm. T = 25°	Relative rate of polymerization T = 14°
Caledon Yellow 5*G*	25	26
Cibanone Yellow *R*	17·8	18·8
Cibanone Orange *R*	10·5	15·5
Cibanone Yellow 2*GR*	7·7	11·4
Caledon Golden Yellow *GK*	5·3	—
Cibanone Orange 6*R*	4·9	6·7
Caledon Red *BN*	2·4	9·5
Caledon Dark Blue *G*	1·2	20·0
Caledon Jade Green *XN*	1·0	5·5
Caledon Jade Green 2*G*	0·9	7·9
Caledon Orange 2*RT*	0·8	—
Caledon Gold Orange 3*G*	0·6	—
Caledon Dark Brown 2*G*	0·1	14·0

In Table 1 the dyes are arranged in order of activity for the autoxidation. This is closely similar to that for the 'tendering' activities of the dyes on cellulosic materials[3]. Both reactions probably have a common origin, namely, the formation of radicals by removal of hydrogen atoms from the substrate by the excited dye. The relative activities in the photopolymerization are not in the same order, and presumably a different mechanism is involved, for example, a direct transfer of energy.

In the case of the autoxidation the general mechanism seems to be established (see following communication), and it is possible to determine the quantum efficiency of the primary process. The following approximate values have been determined for $\lambda = 4500$ A.

Table 2

Dye	Quantum efficiency for sensitization (pO_2 = 100 mm.)
Caledon Golden Yellow *GK*	0·0053
Anthanthrone	0·012
Caledon Red *BN*	0·0021

Comparison with Table 1 shows that for the most active dyes the quantum efficiencies must be very high—close to unity.

We anticipate that photosensitization by dyes may have wide applications, and we are at present engaged in their study.

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[1] For recent summary, see Turner, *J. Soc. Dyers and Col.*, **63**, 372 (1947).
[2] Rabinowitch, "Photosynthesis" (New York, 1945).
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Absolute Velocity Constants in the Autoxidation of Tetralin

THE main features of the autoxidation of unsaturated hydrocarbons have been established by Bolland and Gee[1]. The autoxidation of tetralin probably follows a similar course, although the published work[2] is open to criticism. If the kinetic scheme of Bolland and Gee is accepted, dye photosensitization offers a convenient method of determining the velocity constants absolutely. In our programme of work on absolute velocity constants[3], we have therefore studied the sensitized oxidation of tetralin.

This reaction presents experimental difficulties, since it must be studied at oxygen pressures much lower than those used by Bolland. Under these conditions, the rate of solution of oxygen is not sufficient to keep the liquid saturated. Although allowance can be made for this effect in the steady-state kinetics, it is impracticable to determine the life-time of the chains by standard methods, for example, the rotating sector[4]. Moreover, the reaction has an appreciable rate in the dark, even at 25°. In order to determine the absolute velocity constants, it is therefore necessary to obtain alternative relations between the constants to replace those normally derived from the life-time. By following the reaction in a Warburg-type apparatus, and by applying appropriate corrections, we have been able to measure the true photochemical after-effect. We have established that this is due to the finite life of the chains, and is independent of the initiation step; it therefore provides the required relations. It is also necessary to know the absolute rate of chain starting. This was measured by a standard inhibitor method, the validity of which we have proved in this case.

The steady-state kinetics are consistent with the scheme:

$D + h\nu \rightarrow D^*$	I_{abs}	$TO_2 + TH \rightarrow TO_2H + T$	k_4
$D^* \rightarrow D$	k_f	$2T \rightarrow ?$	k_5
$D^* + O_2 \rightarrow D + O_2$	k_1	$T + TO_2 \rightarrow ?$	k_6 (1)
$D^* + TH \rightarrow DH + T$	k_2	$2TO_2 \rightarrow ?$	k_7
$T + O_2 \rightarrow TO_2$	k_3		

in which D, TH represent dye and tetralin respectively. For long chains, with the approximation[1] $k_6 = \sqrt{k_5 k_7}$, this leads to

$$-\frac{d[O_2]}{dt} = \left\{\frac{k_2 I_{abs}[TH]}{k_f + k_1[O_2]_l + k_2[TH]}\right\}^{1/2} \frac{k_3 k_4 [O_2]_l [TH]}{k_3\sqrt{k_7}\,[O_2]_l + k_4\sqrt{k_5}\,[TH]}, \quad (2)$$

where $[O_2]_l$ is the concentration of oxygen in the liquid. The term in the first bracket on the right of (2) gives the rate of chain-starting; it will be noticed that at high oxygen pressures the excited dye is de-activated by oxygen. We intend to study this reaction in more detail. The after-effect, $\Delta[O_2]$, is given by

$$\Delta[O_2] = \frac{k_3 k_4 [O_2]_l [TH]\{k_3[O_2]_l + k_4[TH]\}}{\{k_3\sqrt{k_7}\,[O_2]_l + k_4\sqrt{k_5}\,[TH]\}^2} \log \tfrac{1}{2}(1 + \xi), \quad (3)$$

where ξ is the ratio of the photochemical and thermal rates. If the reaction has no thermal rate, an analogous expression for ΔO_2 may readily be deduced, but it is more convenient to provide a 'thermal' rate by continuous weak illumination.

Since the rate of chain-starting is known, equations (2) and (3) each provide two relations between the velocity constants k_3, k_4, k_5, k_7. The values obtained for these constants at 25° were $k_3 = 6{\cdot}8 \times 10^7$, $k_4 = 13{\cdot}3$, $k_5 = 7{\cdot}1 \times 10^8$, $k_7 = 2{\cdot}2 \times 10^7$ litre mol.$^{-1}$ sec.$^{-1}$. From the variation of rate with temperature, the following differences of activation energies were found:

$$E_4 - \tfrac{1}{2}E_7 = 4{\cdot}3 \text{ kcal.}$$
$$E_3 - \tfrac{1}{2}E_5 = -1{\cdot}5 \text{ kcal.} \quad (4)$$

From the temperature coefficient of the after-effect at high oxygen pressures, E_4 was found to be 4·2 kcal. Unfortunately, the results at low oxygen pressures were not sufficiently accurate to allow E_3 and E_5 to be determined separately. However, it is unlikely that E_5 is appreciably greater than 2·8 kcal., the value for the termination reaction between similar radicals in the polymerization of styrene[5], and from (4) it cannot be less than 3 kcal.

The following table summarizes these conclusions. Activation energies are probably correct to 1 kcal.

$E_3 = 0$ kcal.	$A_3 = 6{\cdot}8 \times 10^7$
$E_4 = 4{\cdot}3$,,	$A_4 = 1{\cdot}8 \times 10^8$
$E_5 = 3{\cdot}0$,,	$A_5 = 1{\cdot}1 \times 10^9$
$E_7 = 0$,,	$A_7 = 2{\cdot}2 \times 10^7$

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Quantitative Paper Chromatography

Fisher, Parsons and Morrison[1] have shown experimentally that a linear relation holds between the area of the spot of test substance and the logarithm of the concentration at which it is originally applied. A theoretical derivation can now be given.

If it be supposed that the spot spreads by diffusion as it moves along the chromatogram, analogous equations developed in the theory of heat-flow may be applied. For a spot initially at concentration c_i over a circle of radius a, the appropriate equation[2] is:

$$c = \frac{c_i}{2Dt} \cdot \exp\left(\frac{-r^2}{4Dt}\right) \cdot \int_0^a \exp\left(\frac{-r'^2}{4Dt}\right) \times I_0\left(\frac{rr'}{2Dt}\right) \cdot r' \cdot dr',$$

where c is the concentration at radius r at time t, and D is a diffusion constant. Putting F for the integral containing the modified Bessel function, remembering that $r^2/4Dt$ equals $A/4\pi Dt$, where A is the area of the spot, and taking c as the concentration at the limit of visibility, that is, at the edge of the spot, we can take logarithms (to base 10) and rearrange equation 1 to become:

$$A = \frac{4\pi Dt}{\log e}\,[\log c_t - \log c - \log (2Dt) + \log F], \quad (2)$$

which only differs from the experimental relation found by Fisher *et al.* by the term $\log F$; c and Dt are constant for the same substance in the same chromatogram.

Values of $\log F$ were computed graphically in the region of $2Dt$ from 0·02 to 1·50 sq. cm., a from 0·1 to 1·0 cm., and r from 0·1 to 2·0 cm. It was found that a further re-arrangement could be made so that direct use of the simple plotting of A against $\log c_t$ was possible. $\log F$ increases as A increases. Replacing $\log F$ by $(k.A + B + f)$, where k is a proportionality factor, B is the value of $\log F$ when r is zero, and f is the deviation from proportionality, and noting that B equals $\log 2Dt + \log [1 - \exp(-a^2/4Dt)]$, we can write:

$$A = \frac{4\pi Dt}{\log e - 4\pi Dt\,.\,k}$$

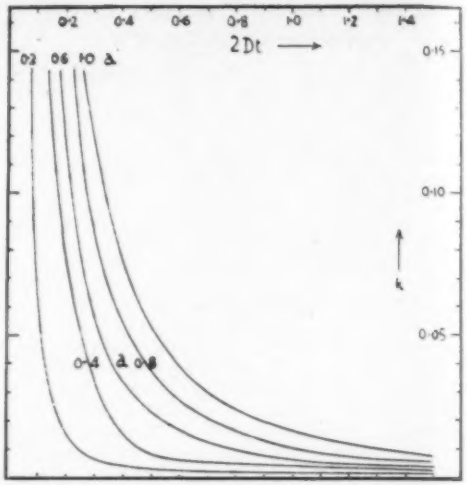
$$\left[\log c_t - \log c + \log\left\{1 - \exp\left(\frac{-a^2}{4Dt}\right)\right\} + f\right]. \quad (3)$$

Values of k and f were computed by drawing a straight line to the plots of $\log F$ against A (up to A equals 7·0 sq. cm.), so that the maximum deviations positively and negatively were equal. The graph shows values of k. The table (from which the accuracy of the computations may be judged) shows the deviation calculated as a percentage; thus a percentage of 1·0 corresponds to the value 0·00432 ($\log 1{\cdot}01$) of f, and may be considered as equivalent to an error in the determination of c_t from the plot of A against $\log c_t$.

	Percentage deviation: a (cm.)				
$2Dt$ (sq. cm.)	0·2	0·4	0·6	0·8	1·0
1·50	0·1	0·4	0·5	0·4	0·3
1·00	0·3	0·5	0·3	0·3	0·3
0·75	0·6	0·1	0·3	0·6	0·6
0·50	0·5	0·5	0·6	0·7	1·7
0·40	1·2	1·2	1·0	1·9	3·3
0·25	1·2	1·0	4·7	6·0	7·1
0·10	6·0	15·0	23·0	7·5	—

The necessity of attaining the higher values of $2Dt$ in experimental work is clear, as is the importance of keeping the initial area of the spots small and uniform.

A practical example may now be considered. By measuring the areas of the spots in the diagrams of the communication of Fisher *et al.*[1] and relating them to the quoted length of 34 cm., the values of the arbitrary units of area may be estimated roughly, and the slope of their lines for the three amino-acids appears to be about 4 sq. cm. From equation 3, the slope S, that is, the factor outside the square brackets, gives $2Dt = 0{\cdot}0691\,.\,S/(1 + k\,.\,S)$. Thus, the value of $2Dt$ for their data cannot be greater than 0·28 (their a values are not given), and their expected error of



2 per cent in the determination of an unknown concentration (c_t) can be realized provided that the value of a is less than 0·4.

An obvious way of improving the accuracy is to run the chromatogram for a longer time, thereby increasing the magnitude of $2Dt$.

I am grateful to Mr. A. J. Ede for helpful criticism and advice.

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Location of Paper Chromatogram Spots of Purine and Pyrimidine Derivatives in Ultra-Violet Light

The methods so far described in the literature for the identification of spots of purines, pyrimidines and their derivatives on paper chromatograms are unsatisfactory. We have found a simple and rapid method for their detection.

If the paper strip run with *n*-butanol as described by Hotchkiss[1] is examined in ultra-violet light transmitted by a Wood's glass or Corning 5970 filter (320–400 mμ) the spots are not visible, though the position of the butanol front is conspicuous as a fluorescent band. Light transmitted by a Corning 9863 filter (230–400 mμ), however, shows the spots as dark patches against the background of paper fluorescence, either by reflected or transmitted light. The most suitable light source was found to be a low-pressure mercury resonance lamp, and further experiments with various filters showed that the intensity in the region of the 254 mμ line was the important factor. The dark patches are probably due to the strong absorption of the radiation which excites the paper fluorescence; their boundaries are readily marked by a pencil so that they can be cut out and eluted for spectrophotometric estimation. The spots are visible down to concentrations of the order of 0·5–1·0 μgm./cm.[2].

The effect has been observed with adenine, adenosine, uracyl, uridine, thymine, cytidine, hypoxanthine, xanthine and various methylated xanthines.

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Noradrenaline in Adrenal Medullary Tumours

Blaschko[1] has suggested the stages by which adrenaline can arise from tyrosine, the final stage being the N-methylation of the primary amine *nor*adrenaline. It is possible that this last stage occurs in the suprarenal medulla; but hitherto *nor*-adrenaline has not been found in the normal suprarenal gland.

A portion of human suprarenal tumour was kindly sent to this laboratory by Dr. E. G. Hall. Histological examination by Dr. P. Glees showed that the tumour was a typical phæochromocytoma consisting of chromaffin tissue. An acid extract of the tumour was prepared and tested for adrenaline and *nor*-adrenaline. The rat's uterus and the frog's perfused heart were used in order to determine the adrenaline content of the extract, since these preparations are insensitive to *nor*adrenaline[2]. It was found that 1 ml. extract was equivalent to 0·37 mgm. adrenaline.

When tested on the rabbit's duodenum and the spinal cat's blood pressure, which are approximately equally sensitive to adrenaline and *nor*adrenaline, the extract was found to be equivalent to 1 mgm. adrenaline per ml. The difference between the activities found on these two types of preparations may be assumed to be due to *nor*adrenaline. Thus 1 gm. tumour contained 3·7 mgm. *l*-adrenaline and 6·3 mgm. *l*-*nor*adrenaline. The presence of both amines was confirmed by tests with polyphenolase which were carried out by Dr. W. O. James. When the enzyme was incubated with tumour extract, a brown colour, typical of *nor*adrenaline, was produced during 10 min. This colour faded, and after 20 min. a rose-pink colour, typical of adrenaline, appeared. This reaction was also given by a mixture of the synthetic amines and is specific for them. James[3] has described a method of separating adrenaline and *nor*adrenaline by paper chromatography. Phenol is used as a solvent, and after 20 hours the positions of the two amines are determined by the pink colour produced by them when the paper is sprayed with potassium ferricyanide solution. The tumour extract gave two spots at positions typical of adrenaline and *nor*adrenaline.

Two other adrenal medullary tumours were also examined. One was sent by Dr. G. M. Wilson from St. Mary's Hospital; 1 gm. of this tumour was found to contain 5·3 mgm. *l*-*nor*adrenaline and 0·32 mgm. *l*-adrenaline. The other was sent by Dr. A. M. Jockes from the British Postgraduate Medical School, and 1 gm. contained 5·5 mgm. *l*-*nor*adrenaline and 0·37 mgm. *l*-adrenaline. These results were obtained from assays against both *l*-adrenaline and *dl*-*nor*adrenaline on the rat's uterus and rabbit's duodenum.

Since *nor*adrenaline has slightly greater pressor activity than adrenaline, it is probable that the attacks of high blood pressure caused by the tumours were mainly due to *nor*adrenaline.

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Gelatination of Blood Serum with Fibrinogen

While much research work is focused on the complex mechanism of biological blood coagulation, comparatively little attention has been paid to the action of fibrinogen on blood serum. Whereas the action of the complete activator system leads with blood-plasma to a relatively firm coagel in a matter of seconds, the action of pure fibrinogen on blood serum leads to an elastic coagel only after two or three hours. This coagel remains transparent, and as there is no apparent sign of coagulation of fibrinogen, we prefer the term 'gelatination'.

The fibrinogen (human) was prepared after the method of Astrup and Darling[1] and was up to 96 per cent clottable. We measured the action on normal blood serum (human), on blood serum and plasma after treatment with barium sulphate (Rosenfield and Tuft[2]) and on a 5 per cent solution of albumin (crystalline, bovine). The mixtures with varying amounts of fibrinogen were in small test tubes at 18° C. The volume in each case is 1·2 ml.

Fibrinogen added (mgm. per cent)	Serum (human)		Barium sulphate serum		Albumin 5 per cent	
	3 hr.	24 hr.	3 hr.	24 hr.	3 hr.	24 hr.
15	++	++	+	++	−	+
30	+++	+++	++	+++	−	++
60	+++	+++	++	+++	−	+++
120	++	+++	+	+++	−	+++
180	+	+++	+	+++	−	+++

+, Marked increase in viscosity; ++, partial gelatination; +++, tube can be reversed without spilling

When 120 mgm. per cent of fibrinogen is added, gelatination of serum is complete after two to three hours, in serum treated with barium sulphate after six hours and in 5 per cent albumin only after eighteen hours. It seems that serum globulins accelerate the process but are not absolutely necessary. No gelatination takes place in oxalated blood plasma after three-fold Seitz-filtration (Owren)[3] or after treatment with barium sulphate.

In order to discover the influence of nucleic acids on gelatination, serum solutions of yeast nucleic acid[4] ($C_{35}H_{48}O_{29}N_{15}P_4$), adenosine-3-phosphoric acid ($C_{10}H_{14}N_5O_7P + H_2O$), adenosine triphosphate ($C_{10}H_{12}O_{12}P_3Na_4$) and thymonucleic acid with a molecular weight of approximately a million were tested in two series: (*a*) concentration of fibrinogen 30 mgm. per cent, and of nucleic acids 917 mgm. per cent; (*b*) 120 and 666 mgm. per cent respectively.

Series	Yeast nucleic acid			Adenosine-3-phosphoric acid			Adenosine triphosphate			Thymonucleic acid		
	3 hr.	7 hr.	24 hr.	3 hr.	7 hr.	24 hr.	3 hr.	7 hr.	24 hr.	3 hr.	7 hr.	24 hr.
a	+	++	++	−	−	−	−	+	+	+	+	++
b	+++	+++	+++	−	−	−	−	+	++	++	++	+++

It follows that yeast nucleic acid as well as thymonucleic acid only slow down the process of gelatination, whereas adenosine-3-phosphoric acid inhibits it. With this latter substance the clotting time of fibrinogen by thrombin is twenty times as long as with yeast nucleic acid[4].

The adenosine-3-phosphoric acid was provided by Messrs. Hoffmann–La Roche and Co., Basle.

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Action of 'Blood-Group Substances' on the Anti-Ken Serum

SINCE the publication of our previous communication[1], we have continued our investigations with the anti-Ken serum, but after adding Witebsky's 'purified blood-group substances', supplied by the courtesy of Sharp and Dohme, Philadelphia.

Testing 248 unselected bloods with the original serum gave the following results[1]:

	+	−
A cells	46	45
O cells	102	55

Testing 300 unselected bloods with the 'absorbed anti-Ken' serum gave a different distribution:

	+	−
A cells	77	73
O cells	76	74

We do not find in our new series tested with the 'absorbed' serum the difference observed previously when using the original serum; but, on the contrary, there is an even ratio of about 50 per cent + and 50 per cent − reactions in both *O*- and *A*-groups. This ratio was actually the one found in the *A*-cell group when using the original serum.

Thus the addition of 'blood-group substances' seems to inhibit the constituent of the original serum responsible for the agglutination of some 15 per cent of extra-bloods in the *O* cell group. This indicates that the original serum contains two antibodies.

Unfortunately, our stock of the original anti-Ken had come to an end when we realized this fact. The patient was bled, but the agglutinin(s) had disappeared from her serum. We are now attempting to get an immune reaction by inoculating her with small amounts of Ken + blood.

Priority in the recognition of the phenomenon we have described should go to R. R. Race[2], when absorbing Andresen's[3] anti-L_3 with the *A* blood-group substance prepared by W. T. J. Morgan. There is, indeed, a close similarity between L_3 and Ken: the positive and negative reactions of anti-L_3 and anti-Ken are distributed similarly with a difference between *O*- and *A*-cell groups; on the other hand, both sera behave in the same way when in contact with 'blood-group substances'.

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'Brassy' Eosinophilic Granulocytes and their Possible Role in Iron Transport

IN blood films stained by one of the Romanowsky modifications, the granules of the eosinophiles are ordinarily scarlet. Occasionally, however, they exhibit a range of colour modification which varies from brownish-red, through grey to almost coal-black. The latter granules are not to be confused with those of the basophilic granulocyte, which have also been found in otherwise unaltered 'eosinophiles' in autochthonous hyperheparinæmias; truly basophilic granules are metachromatic when stained with toluidine blue, while the dark granules of the 'brassy' eosinophiles (as such cells have come to be termed in laboratory parlance) are not basophilic nor do they stain with toluidine blue. The appearance of the 'brassy' granule does not seem to be a staining artefact, as they appear preponderantly in the blood films of certain individuals even though these blood films have been subjected to identical and concurrent staining procedure with films exhibiting the scarlet eosinophilic granule.

The probable nature of the 'brassy' granule was disclosed inadvertently in another connexion. A patient with megaloblastic anæmia was given parenteral liver extract therapy and made a good response with the usual reticulocytosis, increase in blood cholinesterase and eosinophilia, but the anæmia shifted to a hypochromic type. The latter phase was then treated with ferrous lactobionate solution given intravenously. On one occasion, when it was desired to make a routine blood study (to save the patient an additional venipuncture), blood was aspirated directly into the syringe from which the iron solution had just been expressed. The smear from this blood showed all eosinophiles to be of the 'brassy' type. The addition of small quantities of ferrous salts to blood samples was found to convert the ordinary eosinophilic granule to the 'brassy' form. That this form may represent an iron conjugate of the eosinophilic granule is a possibility that might open the additional possibility that the eosinophile is concerned in some phase of iron transport.

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Amino-Acid Constitution of Diphtheria Toxin and Toxoid

WHILE examining by two-dimensional paper partition chromatography the acid hydrolysates of highly purified diphtheria toxin and toxoid, preparatory to attempting the quantitative estimation of the constituent amino-acids by the method of Woiwod[1,2], a striking qualitative difference has been observed between the chromatograms of these two substances, which we feel may be significant.

The photograph of a typical chromatogram of the hydrolysate of toxin is given in Fig. 1, while that of toxoid is shown in Fig. 2. It will be seen that tyrosine is present in the toxin but not in the toxoid hydrolysate. No other major differences have been observed between the chromatograms.

The highly purified diphtheria toxin and toxoid used in this work were prepared by the method of Pope and Linggood (unpublished), and both preparations contained 2,100–2,200 Lfs./mgm. protein nitro-

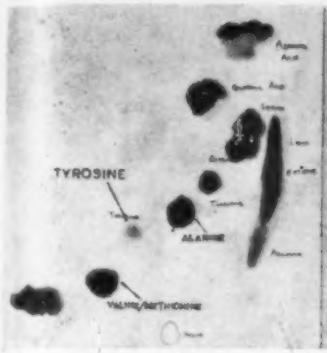

Fig. 1

Fig. 2

gen, but were somewhat less pure in terms of Lfs./mgm. total nitrogen. The non-protein nitrogen was eliminated from both preparations by precipitation and washing with trichloroacetic acid (5 per cent) prior to hydrolysis of the protein with 6*N* hydrochloric acid for 72 hours.

Samples of the hydrolysates containing approximately 200 μgm. of nitrogen were used for the preparation of the two-dimensional chromatograms, which were run first with *n*-butanol-acetic acid and then with phenol.

Holden and Freeman[3], and also Brown[4], have shown that formaldehyde reacts with tyrosine under alkaline conditions to give a product stable to acid hydrolysis, devoid of amino-nitrogen and negative to the ninhydrin test. Therefore, a possible explanation of our observations is that the amino-group in the tyrosine present in diphtheria toxin is not involved in a peptide linkage, but is free to combine with formaldehyde during the process of 'toxoiding'. This is not, however, the only explanation for the apparent lack of tyrosine in the hydrolysed toxoid, and we are engaged in further work to find the actual mechanism involved. This will be published in detail later.

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Beckenham, Kent. Nov. 24.

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Microbiological Oxidation of Sterols

In an earlier communication[1] we stated that by cultivating *Proactinomyces roseus* in a synthetic culture medium in which the only source of carbon and nitrogen was 2 per mille pyridine, and using up the superfluous nitrogen by emulsifying 0·1 per cent cholesterol in the medium and aerating it at 34° C., in two weeks we obtained 7-oxycholesterol and 4,5-cholestonone. Later, we received a letter from Dr. G. A. D. Haslewood, of the Physiological Laboratory, Guy's Hospital, London, S.E., expressing doubt that the occurrence of 7-oxycholesterol was the result of the microbiological oxidation; in his opinion, the result was analogous to the production of 7-oxycholesterol from cholesterol in alkali medium, by aeration and elevated temperature, as shown by Bergström and Wintersteiner[2,3], in which case the micro-organism plays no part.

We have now carried out further experiments. In a synthetic culture medium at *p*H 7, *Proactinomyces* previously cultivated in a 2 per mille pyridine solution decomposes the pyridine into ammonia at 34° C. without special aeration, besides incorporating part of the nitrogen into itself. After complete destruction of the pyridine, the *p*H of the culture rises to 7·5. We then add 0·1 per cent cholesterol to the culture and again 2 per mille pyridine. At the same time we begin aeration at 34° C. Two weeks before extraction of the substances, we determined the *p*H of the cultures and found the average value to be 8·2–8·4.

Control experiments were carried out by regulating the same synthetic pyridine culture medium with ammonia to the minimum *p*H of 7·5 in one control, and in the other to the maximum *p*H value obtained at the end of the culture, that is, 8·2–8·4, and, on adding cholesterol, aerated it under the same conditions as in our chief experiment. In the control experiments we never obtained 7-oxycholesterol at these *p*H values. In a special series of experiments without micro-organisms in the synthetic pyridine culture medium described we found that, with aeration at 34° C., we obtained 7-oxycholesterol only at the outside values of 11–11·5 *p*H, and then only traces.

We must, therefore, repeat that, in the experiments originally reported[1], the 7-oxycholesterol was produced as an effect of the activity of the micro-organism.

A. Kráмli
J. Horváth

Hungarian Biological Research Institute,
Tihany. Nov. 22.

[1] Krámli, A., and Horváth, J., *Nature*, **162**, 619 (1948).
[2] Bergström, S., and Wintersteiner, O., *J. Biol. Chem.*, **141**, 597 (1941); **141**, 503 (1942); **145**, 309, 327 (1942).
[3] Haslewood, G. A. D., *Nature*, **154**, 29 (1944).

Complement Fixation Test in Contagious Ecthyma

During both research and routine complement fixation tests with foot-and-mouth disease virus, we attempted to develop a similar test for the condition known as contagious ecthyma of the lips, infectious or contagious pustular dermatitis or stomatitis and infectious labial dermatitis. The observations clearly indicate that this condition has an extensive geographical distribution.

The technique used was similar to that described by Aramburu[1] for complement fixation test in foot-and-mouth disease. The antigen was made from desiccated crusts from sheep infected experimentally with the virus. The scabs were thoroughly triturated with sand, suspended in 1 in 10 saline and centrifuged 10 min. at 2,500 r.p.m.; the supernatant fluid, containing the antigen, could be preserved for at least fifteen days at − 20° C. Sera were obtained both thirty-one and eight days after infection, centrifuged 15 min. at 3,000 r.p.m. and inactivated 45 min. at ~ 56° C. In our experiments the control tubes included the three types of foot-and-mouth

disease sera, guinea pig normal serum, and both ovine and human normal serum.

Although only eighteen tests were made, all gave positive results, thus demonstrating both the specificity of the test in this condition and the appearance of complement-fixing antibodies in sheep serum. A typical result (Protocol No. 270) is given herewith.

Tube	Antigen	Serum	Saline	Complement	Red cells	Minutes reading 10	20	30
1	0·25	0·05	0·25	0·25	0·5	++++	++++	++++
2	0·25	0·05	0·25	0·25	0·5	++++	++++	++++
3	0·25	0·05	0·25	0·25	0·5	++++	++++	++++

Further experiments with regard to its specificity will be published in due course.

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Alfredo J. García Pirazzi
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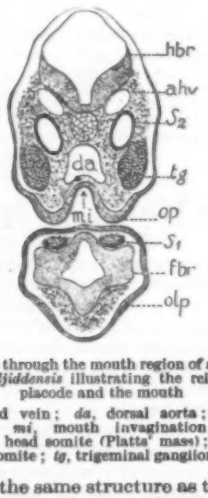
Buenos Aires.
May 20.

[1] Aramburu, H. G., *Rev. Soc. Med. Vet. Bs. As.* (Julio-Septiembre, 1947).

The 'Oral Placode' in Certain Selachii and its Bearing on the Origin of the Vertebrate Mouth

In the course of a study of the early development of the sensory placodes of the head region in some cartilaginous fishes from the Red Sea, namely, *Carcharinus melanopterus* (Quoy and Gaimard), *Rhynchobatus djiddensis* (Bloch and Scheider) and *Rhinobatus halavi* (Müller and Henle), it was found that in the embryos of length 5–10 mm., the epidermis is generally thickened on either side of the roof of the mouth invagination and in the neighbourhood of the hypophysis (see drawing). This ectodermal



Transverse section through the mouth region of a 9·5-mm. embryo of *Rhynchobatus djiddensis* illustrating the relation of the oral placode and the mouth

ahv, anterior head vein; *da*, dorsal aorta; *fbr*, fore-brain; *hbr*, hind-brain; *mi*, mouth invagination; *olp*, olfactory placode; S_1, first head somite (Platta' mass); S_2, second head somite; *tg*, trigeminal ganglion

thickening is of the same structure as the epibranchial placodes which, in these embryonic stages, are situated at the dorsal edges of the corresponding branchial slits. In view of its particular situation over the mouth, it should be regarded as homonymous with these epibranchial placodes and as belonging to them. The structure in question should then have the same relation with the oral slit as the epibranchial placodes have with the spiracle and the following gill-slits. The term 'oral placode' was suggested for this structure, which is thus interpreted as providing an interesting confirmation and adding further evidence to Dohrn's[1] well-known and much discussed[2] theory considering the mouth of vertebrates as derived from a pair of anterior coalesced gill-slits.

Details of this work will be published elsewhere.

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[1] Dohrn, A., "Der Ursprung der Wirbeltiere u. das Prinzip des Funktionswechsels" (Leipzig, 1875).
[2] Naef, A., *Pub. Staz. Zool. Napoli*, **7**, No. 12 (1925).

Shadow Area of Convex Bodies

Vouk[1], in a letter in *Nature*, gave a proof of Cauchy's theorem that the average area of projection of a convex body on a plane equals one-quarter the surface area of the body. The following less formal version of the proof may appeal more to non-mathematicians.

The projected area of a sphere equals the area of a circle of the same radius, that is, $\pi \times (\text{radius})^2$. The surface area is $4\pi \times (\text{radius})^2$. Hence, Cauchy's result is true for a sphere. Because of the symmetry of a sphere, the result must be true of each infinitesimal element of the sphere's surface, that is, any infinitesimal element of area considered in all its possible orientations has an average projected area equal to one quarter of its own area. Now the surface of any convex body consists of a number of such infinitesimal areas; hence by adding the separate contributions from each we obtain Cauchy's theorem. As pointed out by Vouk[1], if the assumption of convexity were not made, the above value of shadow area will be too large, because the contributions of certain surface elements in certain orientations will be nullified by obscuration.

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Sept. 3.

Vouk, V., *Nature*, **162**, 331 (1948).

Bilateral Asymmetry shown by the Metachronal Waves in Protochordate Gill Slits

Because of delay in correcting and returning proofs, the letter under this title in *Nature* of January 22, p. 137, contains an error in the last paragraph. The larvæ of Enteropneusta rotate in an anti-clockwise direction viewed from the animal pole, *not* a clockwise one. To judge from the literature there cited and from a later reference to the subject by van Wijhe[1], the hatching larvæ of *Amphioxus*[2], which are remarkably similar in general appearance to *Saccoglossus* larvæ, rotate consistently in the same direction and swim in a similar manner.

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Jan. 24.

[1] Wijhe, J. W. van, *Proc. Akad. van Wetensch.*, Sect. Sci., **30** (2), 991 (1927).
[2] Hatschek, B., *Arb. Zool. Univ. Wien*, **4**, 1 (1881).

PROBLEMS OF OLD AGE

THE medical, social and economic problems created by a rapidly ageing population were the subject of a symposium presented before a joint session of Sections I (Physiology) and J (Psychology) at the British Association meeting at Brighton on Friday, September 10, 1948.

The subject was introduced by Sir Ernest Rock Carling, who reminded his audience that the great majority of the elderly are healthy and independent —they outnumber the ailing and decrepit by more than 30 to 1—and for them the most pressing problem is how to maintain to the end of their days the standard of living of their working life. The time has come for the elderly to revolt against the convention, based on sociological, not biological, grounds, that there is a fixed retirement-age beyond which they are unfit for further work. It is a truism that chronological age is no guide to capacity in the individual; but what we want to know is, how far the increased expectation of life in the last fifty years has extended working-capacity. Although at sixty to-day we have only a matter of months more to expect than those of that age fifty years ago, nevertheless a far greater number are reaching the sixth and seventh decades, presumably because they have been less subject in early and middle life to diseases which have come largely under control.

Ageing begins at birth, and an athlete is 'old' at thirty-five. Yet what is 'old'? There have been few controlled researches into the causes or processes of ageing. Over the whole range of function we need the help of physiologists to measure such modification as age brings. In war they extended the functional powers of young men to a remarkable extent; by similar study they will certainly be able to suggest optimum conditions for maximum accomplishment when functions are modified or restricted by age. Just as in war combat-stress had to be allowed for, so in peace the stresses inherent in the job may be too great to be easily borne as the years pass: adaptations of work for the elderly must extend to psychological as well as physical demands.

Recent work among the derelict 'chronic sick' has shown remarkable recuperative powers among those thought to be past remedial treatment. If such efforts can restore lost powers, those powers should never have been lost; and continuance in some occupation should be, and is, a sound recommendation for the prolongation of life and happiness. Given some inducement and suitable conditions, the country can draw upon a proportion of the elderly for productive work. For the young disabled there exist workshops where, with special appliances, and adaptations of machines—and a deal of encouragement—selected jobs are accomplished.

Laziness, Sir Ernest maintained, is at the bottom of much facile acceptance of 'too old at forty, fifty, or sixty'. If the Civil servant must retire, why does not the clergyman? If the barrister ceases to practise, why not the judge?

The small percentage of the elderly whose health or social circumstances deteriorate have been in the past scurvily treated. For them the 'institution' must be replaced by small homes, graded to suit the phases of ageing and grouped to enable the residents to pass from semi-independence to full communal care without too much apparent change in surroundings. If local authorities and voluntary bodies co-operate—as they can under the National Assistance Act—it should be possible to throw off the damning inheritance of the 'workhouse' stigma that hangs about public endeavour and the 'charity' that, at least in the prejudices of some local politicians, taints private ventures. Though the proportion of old people badly needing such help may be small, the task of providing for them is enormous, for some two or three thousand homes are needed.

Dr. Marjory Warren followed with a description of her own pioneer geriatric unit at the West Middlesex County Hospital. She maintained that the tendency to lay emphasis on *cure* rather than *care* may be in part responsible for the lack of interest and industry with the so-called incurables. More than 80 per cent of the old people admitted to hospital are suffering from pathological, physiological or psychological conditions which fall under two headings, medical and social. The medical conditions are: degenerative arterial disease, degenerative heart disease, arthritis, malignant diseases, and progressive neurological diseases. The social conditions are lack of hygiene, help, food and company. A service of gerontology is needed which will integrate medical and social care. In addition to domestic and social care, such a service requires three types of accommodation: a geriatric unit based on a general hospital, a long-stay annexe for the truly irremediable, and hostels of various kinds for those reasonably fit who have no suitable home of their own. Medically, all three should be under the same supervision, because the lines between sickness and infirmity, and infirmity and health, become finer as years advance. Yet new legislation now divides the authorities for medical treatment and social care of the elderly.

Dr. Warren described the present position as chaotic and uneconomic. A very large number of remediable old people lie at home under inadequate care and no treatment, unable to get a bed in hospital. In hospitals there are elderly ambulant patients, no longer needing hospital care, for whom no hostel vacancies exist; and in hostels will be found sick old people without access to treatment.

The present writer attempted to set the old-age problem in the context of the larger problem of European population trends, which have social, economic and strategic implications for Western civilization. The population of Europe, having grown enormously—and in relation to world population—in the last three hundred years, has now reached maturity and faces relative decline. To-day it is the non-European populations that are growing fast, with declining death-rates and high birth-rates. North-western Europe—headed by France, once the most populous and now the most 'aged' nation—has led the process, and is destined to contract relatively to eastern Europe, and in particular to the U.S.S.R. Russia, because of late development, is relatively young; and this has a possible strategic significance. It has been estimated that, if present trends continue, another twenty or twenty-five years will see a decrease of nearly 5,000,000 in the man-power of military age in Europe west of U.S.S.R., and an increase of more than 13,000,000 in Russia's military man-power. There is a shift in the balance of man-power from west to east.

The static, perhaps soon declining, populations of western Europe are ageing populations, and their

working populations are ageing and declining. This means that for youngsters it is easier to start work, but harder to advance, since there are fewer opportunities at the top. The difficulty of individual advancement encourages solidarity among workers, accompanied by growing pressure in favour of early retirement—blindly regardless of the fact that the retired have to be maintained from the product of the reduced labour force. The increasing social burden substitutes group responsibility for individual or family responsibility, and the enterprising initiative of an expanding economy is replaced by a longing for the security of an ordered economy. Thus there is created the 'problem of old age'.

In the United Kingdom the present percentage of old people in the population is double what it was in 1901, and treble what it was in 1881—just a life-time ago. It will go on increasing until, in the life-time of many now living, old people will equal or outnumber the children, and the total proportion of dependants (children and old people) to workers will increase from the present 54 per cent to 62 per cent. Only technological progress and increasing productivity will be able to keep pace with this growing social burden.

If the prospect for Britain, and Europe, appears gloomy—with our dwindling man-power and the growing predominance of other cultures—we have to remember that it was Western civilization which, in its vigorous youth, showed the world how to overcome poverty, famine and disease, and so how to release the brake upon population growth. It has yet to be proved that there is any compulsory connexion between social and animal biology, or that an ageing population means a senile body politic.

Mr. A. T. Welford described the tentative results of some experiments, in the Psychological Laboratory at Cambridge, in measuring the achievement of different age-groups at realistic and fairly complex tasks involving motor and mental skill. The first task—throwing chains at a target, first direct, then over a bar, and then with target screened and seen only in a mirror—revealed little difference in accuracy from the 'teens to the sixties until the target was screened, when accuracy fell steadily with age (and the over-thirties tended to look for the chains to throw while the youngsters kept their eyes on the mirror). In the second task the subjects were required to move a pointer on a piece of graph-paper until it corresponded with a small stationary ball on another piece alongside; if successful, the ball had to be started moving and then to be stopped in a new position, and the cycle began again. At this task there was a slightly better total achievement by the under-thirties; but the older subjects' much slower, more deliberate, and also more accurate performance might in a sense be judged more efficient.

In mental skills two experiments were described which required the comprehension and organisation of data. First, in drawing conclusions from a set of logically connected statements, older people tended to treat the statements as real, and to talk about them rather than deduce from them. In the second 'mental' experiment the subjects were required to deduce, by meter-readings, the correspondence between a circuit-diagram and a box with terminals connected underneath by resistances. Here the older age-groups needed to take more readings, some more than once, which indicates their greater difficulty in organising the data and perhaps the beginnings of a loss of short-term memory. In conclusion, Mr. Welford stressed the tentativeness of all these interpretations, but suggested that an important locus of change with age lay in the manner of organising data or comprehending a display.

Mrs. Barbara Lewis dealt with one aspect of the economic consequences of an ageing population, namely, the employment of older workers. Since such employment may become an economic necessity, it needs to be examined from both the old people's and the employers' points of view. Are old people willing to work, and is their work economic? Like all recent investigators, Mrs. Lewis was able to confirm, from her Birmingham survey of the over-seventies, the therapeutic value of continued occupation: that women live longer than men is undoubtedly influenced by men's tendency to retire with a jolt at a fixed age, while women suffer no such sharp break. Though some men look forward to freedom to pursue hobbies and interests, there is a difference between the social and occupational groups: clerks and managers usually relish the prospect of retirement but are deterred by the certainty of a much lower standard of living, whereas manual workers frequently complain of boredom in the retirement into which they have been tempted by the smaller gap between earnings and pension.

The old people available and able for employment fall into three groups: those preferring and intending to work as long as possible; those failing or tired, who look forward to ceasing work as soon as they are financially able to retire; and those less definite about retirement, who could be swayed by a pension scheme offering greater inducements (than does the National Insurance Act, 1946) to postpone retirement or by special conditions of work if they continue.

From the employers' point of view, it is generally only when loss of efficiency and the need for transference to lighter work arises that there is formal consideration of an employee's age and capacity. (On the staff side it is different, and strictly enforced retiring-ages are common, to preserve reasonable prospects of promotion.) There is no difficulty about retaining skilled craftsmen, even when pace and output fall off; but the unskilled or semi-skilled factory worker, who may, especially in heavy trades, lose efficiency with increasing years, is not so easy to retain, since alternative lighter work may be difficult or impossible to arrange. Even where old men could successfully undertake work normally done by women or boys, the trade unions' insistence on the minimum adult man's rate makes old men too expensive to use. Even if two old men could be paid only half a younger man's rate to reach the younger man's output, the costs of production will still be higher, since the administrative costs per worker have to be taken into account. On the other hand, older workers have many recommendations: they are normally more conscientious and better time-keepers, have greater respect for rules and the employer's property, and generally mind their jobs more carefully, knowing that other work will be hard to find.

As a consequence of an ageing population, industry will have to adjust itself to a labour force with a higher proportion of older workers. This may involve more mechanization and the further elimination of heavy exertion, possibly some special conditions for elderly workers, and certainly a considerable amount of research and job-analysis to reveal the types of work most suited to the employment of older workers. Mrs. Lewis concluded the symposium with the cheerful reflexion that, in encouraging old people to

remain as long as possible in employment, the best interests of the nation and the aged coincide.

In the discussion that followed, it was clear that some lay members of the public, at least, are more interested in the causes of ageing and in the search for some partial elixir of life than in the more serious problems raised for society by a rapidly ageing population. W. A. SANDERSON

NEW BUILDING MATERIALS

THE widespread incidence of the shortage of houses justifies even a belated account of a discussion on "Building Materials with Special Reference to New Materials", held in Section B (Chemistry) of the British Association on September 14. The full text of the four main papers read at the discussion has already been published*.

Speaking on "Some Modern Trends in Building Materials", Dr. F. M. Lea, director of building research, Department of Scientific and Industrial Research, described the factors which influence both the development of new materials and new methods and their assimilation into the traditional structure of the building industry—developments which have made it essential to study building scientifically with the object of reshaping its traditions to modern needs. The potential demand for building materials is so large that the industry offers an attractive field for exploitation of newly discovered materials and a prospective outlet for industrial by-products. To be successful, a new material must be suitable in all needful respects for the purpose for which it is intended, and must be capable of being used without major change in existing craft processes. Large manufacturing resources and ample supplies of raw materials are essential if a new product is to become generally used. The industry can readily absorb new materials introduced on a relatively small scale, and these, if they prove to meet a real need, can be commercially successful and lead to the establishment of major industries, as has happened, for example, with asbestos-cement products, concrete roofing-tiles and fibre boards. Increased stress on functional requirements—thermal insulation, sound insulation and so on—leads to consideration of how the technical needs can be met by materials singly or in combination with others. This stimulates the development of new materials or new ways of using them. Changes must of necessity be slow because new materials and new techniques have to be grafted on to an established body of practice by a widely scattered labour force.

Dealing with "The Use of Aluminium Alloys in Building", Mr. E. I. Brimelow, of the Chief Scientific Adviser's Division, Ministry of Works, described the rapid growth of the aluminium industry which has brought aluminium and its alloys to the status of engineering materials in little more than a century. The strength of aluminium alloys compares favourably with that of mild steel; the lower modulus of elasticity can be allowed for by appropriate increase in the dimensions of structural members without undue increase in weight. The relatively low melting point need cause no anxiety about the fire-resistance of loaded members; it is necessary only to provide a thicker covering for insulation and fire protection to obtain a performance comparable with that of steel. The low density of aluminium and its versatility of form fit it for use as a decorative material, as window-frames and rain-water goods, and, with due discrimination, for plumbing. It is used for spray coatings and as scaffolding. The low emissivity of clean, bright aluminium foil allows it to be used in cavity types of construction as an insulating material. Though generally resistant to corrosion, some precautions are necessary in the use and maintenance of aluminium and its alloys. Anodizing affords useful protection and gives a good surface for painting, which is recommended for rain-water goods in industrial and coastal districts. The good appearance of aluminium window-frames can be maintained by regular washing with water or by polishing with wax. In plumbing applications, electrolytic corrosion can be avoided by appropriate choice of the associated materials and by use of insulating washers. Use of aluminium for hot- and cold-water supply installations will not be advisable until the cause of a pitting type of corrosion which occurs in some districts has been further studied. The aluminium bungalow, using aluminium in combination with foamed-concrete insulation, has made a substantial contribution to the temporary-housing programme. With some improvements, the method of construction is being extended to provide permanent houses, schools and factories. Shortage of building materials has given opportunity for trial of those new uses for aluminium which could be technically justified, and the experience so gained will be a valuable guide for the future. The advent of cheaper methods of production would increase its potentialities.

Dr. T. W. Parker, of the Building Research Station, dealt with "Light-weight Building Materials", development of which has been fostered by present demands for thermal efficiency arising from the desire to achieve economy in fuel consumption and to provide increased comfort for the occupants. Low-density blocks can be used as load-bearing materials; sheet materials form linings or cladding; fibrous or granular materials are used as 'loose fill' or as blankets or 'bats'. Light-weight blocks, besides having a substantial insulating value, have the merit of high thermal capacity, the importance of which is often overlooked. Its influence in smoothing out variations in temperature is particularly valuable where intermittent methods of heating are installed. The greatest advance among low-density materials has been in the development of cellular concrete, which can be made in a number of different ways with a density of 20 lb. per cu. ft. upwards. Except in the aluminium bungalow, this material has not yet been used to any great extent in Great Britain, but experience in Sweden has demonstrated its potentialities. Light-weight sheets used as wall linings provide thermal insulation and offer a surface that can be quickly warmed to a comfortable temperature. Such materials must be robust enough to withstand accidental damage. They must not introduce an additional fire hazard. When circumstances preclude the use of low-density boards, the desired thermal resistance can be attained by using stronger boards fixed with an air space behind them. 'Loose fills', blankets and 'bats' form a convenient form of insulation for hollow walls and for roofs and ceilings. They must be chemically and physically stable, and should not give off noxious or combustible gases in the event of fire. They are mostly made from glass-wool, slag-wool or mineral-wool. Production of vermiculite in South Africa has stimulated interest in expanded vermiculite

* *The Builder*, **175**, 335, 365, 393, 454 (1948).

for use as 'loose fill', as concrete aggregate, and as a constituent of insulating plaster applied by spraying. Its cost is at present higher than that of other forms of insulation.

Speaking on "The Use of Plastics in Building", Mr. R. J. Schaffer, of the Building Research Station, stressed the importance of selecting the building (and all other) applications of plastics with due regard to their suitability for the purpose intended. The idea of using plastics, other than resin-bonded wood, as load-bearing members is no longer of practical interest. Thermoplastics are obviously unsuitable for such use; the low modulus of elasticity, lack of ductility and high cost make it impracticable to use thermo-setting plastics. The advent of synthetic, waterproof glues has increased the potentialities of plywood and of glued construction in timber, and has led to the development of new kinds of building-board made from wood-waste or other by-products. Plastics enter into the composition of a variety of flooring materials. Polyethylene, already used for piping beer, etc., promises to be useful for domestic cold-water supply and sanitary installations. Foamed or 'expanded' plastics may be used for thermal insulation. There is a wide scope for the use of moulded plastics as building fittings; adoption of the British Standards Institution certification mark will ensure that high standards of design and workmanship are maintained. R. J. SCHAFFER

THE NUFFIELD FOUNDATION

THE third report of the trustees of the Nuffield Foundation*, which includes a list of 'fellows' appointed during the year, the balance sheet and a schedule of grants, records an allocation of grants during the year ended March 31, 1948, amounting to £495,350, the largest of any year up to date. The grants allocated since 1943 now total £2,135,980; this includes £605,850 to medical sciences; £242,000 to natural sciences; £142,000 to social sciences; £509,900 (including £225,000 over fifteen years to the Dominion Students' Hall Trust for the development of London House) for fellowships and scholarships; and £589,700 (of which £500,000 is to the National Corporation for the Care of Old People) for the care and comfort of the aged poor. During 1947, the resources of the Trust have been enriched by a gift of £450,000 from Capt. Oliver Bird. This benefaction, to be known as the Oliver Bird Fund, is to be held on trust for promoting research into the prevention and cure of rheumatism or, failing that, for the advancement of health and relief of other sickness. The trustees are now turning their attention to the planning of the programme for the next quinquennium, and they point out that the welcome increase of State support for learning and research does not lessen the need for voluntary enterprise or decrease the importance of alternative sources of support if the principle—fundamental to a free and democratic society—is to be upheld that "there should be room for more than one opinion and for more than one means of putting that opinion to the test".

A new grant in the medical sciences of £50,000, payable as required over ten years, goes towards the capital and maintenance costs of a hæmatological research unit to be set up by the Medical School of the University of Oxford, in conjunction with the Nuffield Department of Clinical Medicine under Prof. L. J. Witts, and the Radcliffe Infirmary Department of Pathology under Dr. A. H. Robb-Smith. A second new grant of £4,000 has been made towards the expenses of a new inquiry into the relation of infant mortality and morbidity to environment for the whole of Great Britain. This inquiry is to be undertaken by the joint committee of the Royal College of Obstetricians and Gynæcologists and the Population Investigation Committee, with help from the Institute of Child Health of the University of London. Like the inquiry into the maternity services, begun in 1945, it will also require the help of the medical officers of health and health visitors. Progress has also been made during the year in building up a comprehensive rheumatism service under the Medical School, University of Manchester; in addition to clinical work in Manchester and Preston, an experimental clinic is being established at Walkden for the diagnosis and treatment of rheumatism in coal-miners, and an investigation commenced into the role of the oral septic focus in chronic rheumatism. The five-year study of student health at the Institute of Social Medicine, Oxford, commenced in January 1947, and as a result of a conference on student health at the Institute in July 1947, student-health services which are starting at other universities will be co-ordinated with the Oxford service to achieve comparable records and statistics. The first year's work under Prof. J. Z. Young in the Department of Anatomy, University College, London, on the mechanism of learning in various animals has confirmed the hope that study of the structure of the brain and the learning powers of cephalopods (and especially the octopus) will throw light on the nature of the learning process.

New grants in the natural sciences during the year have been for a scientific study of the principles that should guide agricultural policy in Britain, and £18,000 over five years to the University of Bristol for research under Dr. C. R. Burch on the improvement of the reflecting microscope and for an attempt to solve the problems involved in the manufacture of the microscope by machinery. The agricultural study is being conducted by Mr. T. E. Eastwood, under the guidance of a committee of which Sir William Goodenough is chairman. At the University of Birmingham progress is reported in work under Prof. M. L. Oliphant upon the design and creation of new equipment for further fundamental studies in nuclear physics. An additional research fellow has been appointed to the staff working under Prof. P. I. Dee at Glasgow, and in addition to successful work with the million-volt generator and thirty-million-volt synchotron, results of fundamental interest have been obtained in the development of 'detection' techniques for use with these machines. In the biomolecular research laboratory at Birkbeck College, London, under Prof. J. D. Bernal, the X-ray analysis group is studying crystalline proteins and viruses, as well as simpler and related organic compounds which might provide clues to the structure of the proteins themselves. Dr. S. Levine's extensive theoretical work has shown that long-range forces between colloidal particles can originate in the electrical double layers at the surfaces of the particles. Results obtained in cosmic-ray research under Prof. P. M. S. Blackett at the University of Manchester have already been described in *Nature* (**160**, 855; 1947), and a cloud chamber is now operating at the Jung-

* Nuffield Foundation. Report of the Trustees for the Year ending 31 March, 1948. Pp. 92. (12–13 Mecklenburgh Square, London, W.C.1.)

fraujoch Laboratory, Switzerland, for further study of these new particles. Measurements of extensive showers with a very elaborate hodoscope are being started, and fundamental work on temperature and meteorological effects of cosmic rays is continuing.

Six research fellows are now working at the Clarendon Laboratory, Oxford, under Lord Cherwell, and the low-temperature department of the Laboratory has now been built up again; while in the small chemical laboratory of the Laboratory the use of chemical methods as an aid to exact methods in nuclear physics is being developed. At the Cavendish Laboratory, Cambridge, Dr. E. Orowan's group of research workers has developed a theory of low-temperature creep in metals and a photo-elastic method of recording the distribution of roll-pressure over the area of contact, and have investigated a new mechanism of recrystallization in cold-worked metals. In the investigation at the University of Cambridge into the mechanical properties of soil, the study of soil dynamics has centred largely on the improvement of the oscillograph apparatus for the simultaneous recording of the component soil forces on the tillage implement. A theory of the relation between the permeability of a structured material such as soil and its pore-size distribution has been checked by observation on the permeability over a wide range of moisture contents.

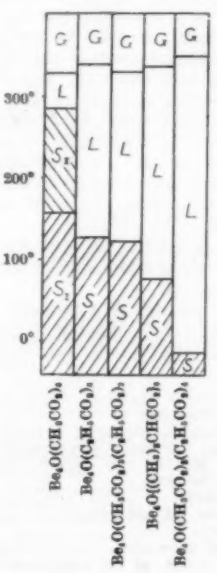
New grants in the social sciences have been made to the Department of Social Science, University of Liverpool (£7,000 over five years), for a study of group relations and an investigation into social factors of town planning; to the Social Research Division of the London School of Economics and Political Science (£20,000 over five years) towards a comprehensive study of social selection and differentiation with particular reference to the middle class; and to the Institute of Psychiatry, University of London (£20,000 over ten years), for a long-term investigation of the traditional methods of selecting students in comparison with a procedure using various psychological tests, and relation of the assessment with the subsequent careers of the individuals tested. A further grant of £1,000 to the National Institute of Economic and Social Research is to be used in support of the project, "Lessons of the British War Economy". Substantial starts are reported by the recipients of grants approved last year; the Administrative Staff College has commenced its activities, and the Population Investigation Committee has launched a large-scale field study of the trend of intelligence.

Steady progress is reported towards the realization of the Foundation's fellowship policy of a two-way traffic between the various parts of the Commonwealth and Empire of students of varying seniority and fields of interest. The Dominion medical travelling fellowships scheme has proved so successful that it is being continued, with slight modifications, for a further seven years; and the small scheme to enable practical farmers of England and Wales to study modern farming methods abroad has been extended to Scottish farmers. For medical men in the outlying parts of the African Colonies, the Foundation has made a grant of £30,000 to finance for six years periodic visits by a panel of medical consultants from Britain. Reference has already been made to the grant of £500,000 to the new National Corporation for the Care of Old People. The Foundation's own policy is to continue financial support to this Corporation, but, in conformity with its own interests in the problems of health, it will consider projects of research into causes of ageing. The report pays a tribute to Dr. J. H. Sheldon's report on "The Social Medicine of Old Age", although the publication falls just outside the year under review. Among the miscellaneous grants of the year is £1,000 a year for five years towards the maintenance and extension of the activities of the Universities Bureau of the British Empire (now the Association of Universities of the British Commonwealth).

POLYMORPHISM OF BERYLLIUM OXYACETATE

WE have found a transition of beryllium oxyacetate hitherto unrecorded. The transition occurs at about 160° C., and when the temperature is raised above this point the substance assumes gradually the appearance of soft wax, though it melts sharply at 285° C. The melting point of this substance is abnormally high as compared with those of other members of the homologous series, as is seen in the figure. It suggests that the high-temperature phase has some unusual structure in which the molecules are held together, forming a crystal lattice, but presumably with a higher order of freedom in its molecular motion, thus resembling the melt in its molecular state. This view is supported by the fact that the intensities of X-ray spectra taken with this phase fall off rapidly with increase of diffraction angles.

The configuration and symmetry of the molecule of this substance seem to fulfil the requirements put forward by Timmermans[1] for substances which give the so-called 'plastic crystals'. In fact, beryllium oxyacetate above the transition temperature much resembles in appearance the high-temperature modifications of pentaerythritol[2], tetranitromethane[3], cyclohexanol[4], etc., which are examples of plastic crystals.



The X-ray powder photographs taken with this substance slightly above the transition temperature and somewhat below the melting point are similar, but the relative intensities are not the same. Most of the lines observed can be accounted for as the lattice has a rhombohedral unit with dimensions $a_r = 9{\cdot}72$ kX., $\alpha = 54°\ 20'$, containing one molecule in it (copper $K\alpha$ radiation was used). The arrangement of molecules may be such that the centres of molecules occupy the rhombohedral lattice points; but the existence of a few lines which cannot be accounted for with this unit shows that the translation of the structure is not exactly rhombohedral but one having a lower symmetry.

It has been reported by Preston and Trotter[4] and by Beevers[5] that the symmetry of the Laue photographs of the cubic oxyacetate changes from $T_h - m3$ to $O_h - m3m$ in the interval 30–50° C. Jaffray[7] made a thermal analysis and found that at 40·5 ± 0·5° C. there is a change in the heat capacity curve typical of the λ-type. According to Beevers, this change is due to a change in the parameter values of the carboxyl oxygen atom from (−0·17, −0·06, −0·04) to (−0·17, −0·05, −0·05), as the temperature passes the transition range, thus bringing all the oxygen atoms exactly to the (110) planes. We have re-examined the substance by the Laue photographic method and found that the holohedral symmetry is first attained at 60° C. Moreover, we have found on the photographs taken with the X-ray beam perpendicular to the (111) planes a number of diffuse spots, the intensities of which are enhanced considerably on passing the transition temperature.

A tentative theory is put forward. The symmetry of the molecule in the low-temperature form is $T-23$, and the higher symmetry of the crystal $T_h - m3$ can be described as containing two kinds of molecules the mirror images of which are arranged regularly in accordance with the symmetry of the space group. If the packing of the molecules be kept as before but the two forms of the molecules be found at random, the symmetry of the crystal would attain the higher one $O_h - m3m$ in a statistical sense. This may be explained in another way as follows. The potential change associated with the rotation of the carboxyl group around the carbon-to-carbon bond parallel to the crystallographic axis would have a maximum when the oxygen atoms pass the (110) plane, and if the height of this barrier be low compared to the thermal energy, the oxygen atoms would pass over this barrier and arrive at another position of minimum energy which lies symmetrically to the (110) plane. This may transform the configuration of the molecule to its mirror image form if the change should occur simultaneously in six carboxyl groups within a molecule. Such may be the mechanism of the above-mentioned transformation.

Another modification of beryllium oxyacetate can be obtained by sublimation[6]. It is reported that this modification is birefringent and unstable at room temperature, transforming gradually when left by itself, or rapidly by grinding, into the cubic modification. The Laue rotating crystal and the moving-film goniometer photographs show that the crystal has a monoclinic unit with $a = 13{\cdot}75$ kX., $b = 9{\cdot}24$ kX., $c = 16{\cdot}21$ kX., $\alpha = 98°\ 55'$, $Z = 4$ (copper-Kα radiation was used throughout), and the corresponding space group is one of $C_s^1 - Pm$, $C_2^1 - P2$ or $C_{2h}^1 - P2/m$.

Detailed analyses of the structures of different modifications are now going on, and the results will be published later.

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July 15.

[1] Timmermans, J., *J. Chim. phys.*, **35**, 331 (1939).
[2] Nitta, I., and Watanabé, T., *Bull. Chem. Soc. Japan*, **13**, 28 (1938).
[3] Oda, T., Iida, T., and Nitta, I., *J. Chem. Soc. Japan*, **64**, 616 (1943); Oda, T., and Watanabé, T., *ibid.*, **65**, 154 (1944); Oda, T., and Nitta, I., *ibid.*, **65**, 621 (1944) (in Japanese).
[4] Oda, T., *X-rays*, **5**, 2 (1945) (in Japanese).
[5] Preston, G. D., and Trotter, J., *Nature*, **151**, 166 (1943).
[6] Beevers, C. A., *Nature*, **152**, 447 (1943).
[7] Jaffray, J., *C.R. Acad. Sci., Paris*, **225**, 106 (1947).
[8] "Gmelins Handb. anorgan. Chemie", 8 Aufl., **28**, 152 (1930).

We have carried out differential thermal analyses of beryllium oxyacetate in order to find accurate transition and melting points and also to examine the heat effect associated with these (Fig. 1). The

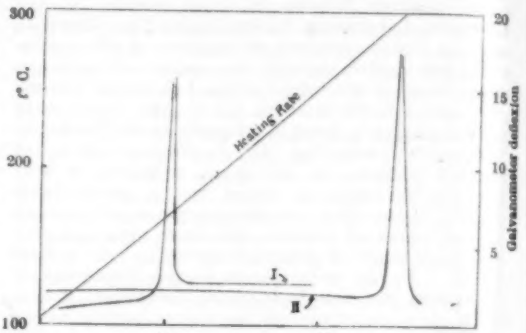

Fig. 1

observed transition and melting points are 148° C. and 286·7° C., respectively. If the sample is heated up to about 250° C. and then cooled to the room temperature, there is observed no transition phenomena in the cooling curve; this behaviour persists, for no transition phenomena is shown by the heating curve obtained on the next day (see curve II). But, when the sample is not heated beyond about 210° C., the transition in the heating curve made on the next day is always observed. The velocity of transition is accelerated by grinding the supercooled sample in an agate mortar. But this effect is somewhat complex. Details of the observation will be reported elsewhere. Comparison of the two peaks in the curves of the thermal analysis reveals that the heat of transition is nearly equal to the heat of fusion.

We have also made a dilatometric investigation. The results are shown in Fig. 2. It is found that the thermal expansion coefficient changes at four different temperatures, namely, 32° C., 42° C., 7 7° C and 124° C. At all these temperatures except the

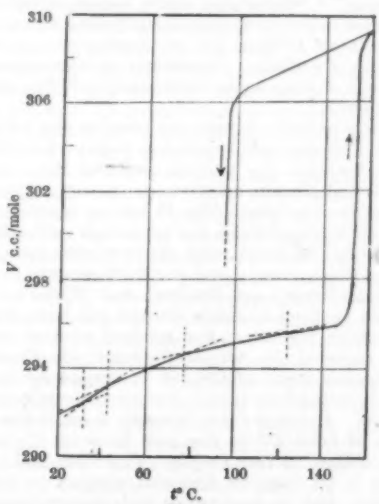

Fig. 2

first the expansion coefficient decreases on the high-temperature side. The second one corresponds to the temperature observed by Jaffray in his calorimetric measurement and reported as 40·5 ± 0·5° C. The third of such changes is the largest, and the last is the smallest. The volume change at 148° C. is nearly 5·7 per cent of the volume at 25° C. Numerical data of these changes and the volume change at the melting point not described here will be given elsewhere.

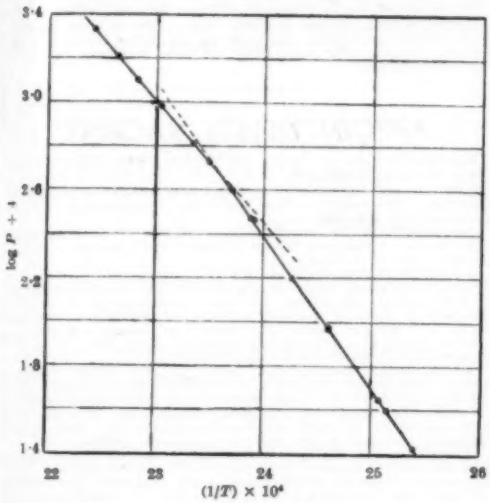

Fig. 3

We have also measured the sublimation pressure of this substance below and above the transition points by the effusion method. The vapour pressure equation obtained below the transition point is $\log P = -6934 \cdot 8/T + 15 \cdot 0299$, and above is $\log P = -5922 \cdot 8/T + 12 \cdot 6266$ (Fig. 3). From these equations, the heat of sublimation and of transition as well as the entropy changes are calculated (see table). The entropy change at the melting point is calculated by comparing the areas of the two peaks in the curve of the thermal analysis with the heat of transition obtained from the vapour-pressure measurement. These entropy data seem to explain why this substance has a very narrow range of liquid state in contrast to other members of the homologous series.

$\Delta H_{subl.}$ kcal./mole	$\Delta H_{trans.}$	$\Delta S_{trans.}$ e.u.	ΔS_{fusion}
31·7 (low-temp. phase) 27·1 (high-temp. phase)	4·6	11·0	11·6

We are now attempting to measure the heat capacity of this substance. Discussion of the mechanism of this transition phenomena will be given later.

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SEED STORAGE OF INDIAN FOREST PLANTS

Mr. T. V. Dent, of the Indian Forest Service, has published some valuable information on the theoretical and practical aspects of seed storage, together with a discussion of the near-related principles of the duration of seed viability, dormancy, germination and the testing of seeds (*Indian Forest Records (New Series): Sylviculture*, vol. 7, No. 1 (Manager of Publications, Delhi)). In addition, an attempt is made to screen and correlate all available information on the duration of vitality and on the storage of seed of Indian forest plants.

Mr. Dent writes that it is suggested that the time is now ripe for the initiation of a carefully prepared programme of research into storage of seed and near-related problems, in particular pre-sowing treatments for seeds which are difficult to germinate. Action should be initiated by the central sylviculturist, and an all-India plan of action should be devised, with the co-operation of provincial forest research officers. The shortcomings of our past methods, and the lacunæ in our knowledge of seed storage matters, are revealed by the information tabulated in this record. Here we have our starting point for planning the investigations of the future.

The monograph is divided into two parts, of which Part 1 deals with general principles relating to seed storage and is divided into nine sections covering the following: the practical importance of tree seed storage in forestry, the germination of seeds, dormancy, the duration of seed viability, the collection and extraction of tree seed, methods of seed storage, the protection of stored seed from pests, the transportation of seed and the testing of tree seed. Part 2 deals with available seed storage data for Indian forest plants and includes two tables presenting in summarized form all the principal information which is at present available on the storage and longevity of the seed of Indian forest plants.

In Great Britain it is understood how important is a knowledge of how to store seed of forest trees. It is not surprising, therefore, that India has had to consider this matter carefully, since a very much larger number of tree seeds, both indigenous and exotic, are made use of in the sub-continent of India; at the present time, at least 20,000 acres of land are artificially afforested a year, and under new proposals this area may be very considerably enlarged.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 7

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Electrical Engineering taught to other than Electrical Engineers" (to be opened by Prof. A. A. Hall and Mr. H. C. Mann).

Manchester Geographical Society (at the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Miss Dorothy M. Scott: "Southern Rhodesia and the Cape".

Textile Institute (joint meeting with the Society of Dyers and Colourists and the Society of Chemical Industry, at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Dr. E. S. Paice: "Detergents".

Chemical Society, Oxford Section (in the Physical Chemistry Laboratory, Oxford), at 8.15 p.m.—Prof. C. A. Coulson: "Localised and Non-Localised Bonds" (Alembic Club Lecture).

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. A. B. Crawford: "The Life of the Tristan Islanders".

Tuesday, February 8

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. Kenneth P. Oakley: "The Origins of Tool-Making".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. Pierre Lépine (Institut Pasteur, Paris): "Virus Research and the Virus Problem".*

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (joint meeting with the UTILISATION SECTION, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. T. Winch: "The Measurement of Light and Colour". (To be repeated on Wednesday, March 2, at the City Council Chambers, Clarence Parade, Portsmouth, at 6.30 p.m.)

INSTITUTION OF ELECTRICAL ENGINEERS, EAST MIDLAND CENTRE (at the Y.W.C.A., Nottingham), at 6.30 p.m.—Mr. F. J. Erroll and the Lord Forrester: "Some Projects favourable to Direct-Current Transmission, and the Role of the British Electrical Industry in relation Thereto". (To be repeated on Tuesday, April 5, at the Yorkshire Electricity Board Offices, 1 Whitehall Road, Leeds, at 6.30 p.m.; on Wednesday, April 6, at the Cleveland Scientific and Technical Institute, Middlesbrough, at 6.30 p.m.; and on Monday, April 25, at the South Wales Institute of Engineers, Park Place, Cardiff, at 5 p.m.)

BRITISH ESPERANTIST SCIENTIFIC ASSOCIATION (in the Psychology Department, University College, Gower Street, London, W.C.1), at 7 p.m.—Second Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY (at 16 Princes Gate, London, S.W.7), at 7 p.m.—"Integral Photography" (a paper on the Land Process).

CHEMICAL SOCIETY, EDINBURGH SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY, and the EDINBURGH UNIVERSITY CHEMICAL SOCIETY, in the Biochemistry Lecture Theatre, The University, Edinburgh), at 7.30 p.m.—Prof. R. D. Haworth, F.R.S.: "Some Recent Advances in the Chemistry of Natural Products".

Wednesday, February 9

LINNEAN SOCIETY OF LONDON (in conjunction with the SYSTEMATICS ASSOCIATION, at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. John Smart: "Post-Darwinian Development of Taxonomy (Zoology)".

CHEMICAL SOCIETY, NORTHERN IRELAND SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department Lecture Theatre, Queen's University, Belfast), at 7.30 p.m.—Prof. A. R. Ubbelohde: "Some Problems of the Sensitiveness of Explosives".

SOCIETY OF DYERS AND COLOURISTS, NORTHERN IRELAND SECTION (in the Queen's Hotel, Belfast), at 7.30 p.m.—Dr. T. Vickerstaff: "A Study of the Factors Controlling Dyeing Behaviour".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.30 p.m.—Mr. C. A. Whitmarsh: "Introduction to the Measurement of Radioactivity in a Factory".

Thursday, February 10

INSTITUTION OF ELECTRICAL ENGINEERS, SOUTH-WESTERN SUB-CENTRE (at the Electric Hall, Torquay), at 3 p.m.—Mr. C. A. Cameron Brown and Mr. E. W. Golding: "The Application of Electricity to Horticulture". (To be repeated on Monday, March 14, at the Imperial Hotel, Birmingham, at 6 p.m.)

CHEMICAL SOCIETY, LIVERPOOL SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY and the BRITISH ASSOCIATION OF CHEMISTS, at the University, Liverpool), at 4.30 p.m.—Dr. G. Gee: "Recent Advances in the Physical Chemistry of High Polymers".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Song of Birds" (to be opened by Mr. James Fisher).

CHEMICAL SOCIETY, ST. ANDREWS AND DUNDEE BRANCH (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY and in conjunction with the BRITISH ASSOCIATION (DUNDEE) TRUST, in the Chemistry Department, University College, Dundee), at 5.30 p.m.—Dr. W. G. Ogg: "Soil Fertility".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—M. Brocard and M. Hussenot: "French Practical Aerodynamic Methods" (Second Louis Bleriot Lecture).

ROYAL METEOROLOGICAL SOCIETY (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 6 p.m.—Sir Nelson Johnson, K.C.B.: "Some International Aspects of Meteorology".*

SOCIETY OF DYERS AND COLOURISTS, MIDLANDS SECTION (at the Midland Hotel, Derby), at 7 p.m.—Dr. L. P. Moore: "Some New American Fibres".

WOMEN'S ENGINEERING SOCIETY (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—Mr. E. J. Steadman: "X-Rays in Medicine and Industry".

Friday, February 11

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting.

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM SECTION (in the Chemistry Department, King's College, Newcastle-upon-Tyne), at 5 p.m.—Dr. A. J. B. Martin: "Partition Chromatography" (Bedson Club Lecture).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. W. L. Hughes: "Vibration of Propeller Blades"; Prof. L. C. Burrill: "Underwater Propeller Tests".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. Peter Scott: "The Preservation of Wildfowl—The World Problem".

Saturday, February 12

BIOCHEMICAL SOCIETY (at the Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1), at 11 a.m.—Scientific Papers.

BRITISH PSYCHOLOGICAL SOCIETY (joint meeting with the COLOUR GROUP of the PHYSICAL SOCIETY, in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Discussion on "The Techniques and Methods of Interpretation of Experiments in Colour as carried out by Physicists, Physiologists and Psychologists".

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 8 p.m.—Dr. J. C. Flugel: "Some Neglected Aspects of World Integration".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE DEPARTMENT OF PURE AND APPLIED SCIENCE AND CHEMICAL ENGINEERING—The Registrar, Loughborough College, Loughborough (February 12).

BIOCHEMIST for the investigation of diseases of farm animals—The Director, Agricultural Research Council Field Station, Compton, Newbury, Berks (February 14).

SCIENTIFIC OFFICERS or EXPERIMENTAL OFFICERS with good honours degree in a biological science or in chemistry, with research experience in biochemistry, physiology, pathology, pharmacology or bacterial chemistry, in Ministry of Supply research and development establishments in Wilts and Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.550/48 (February 19).

METALLURGISTS (unestablished, Senior Scientific Officer, Scientific Officer, Experimental Officer and Assistant Experimental Officer grades) in Ministry of Supply research and development establishments in London and South England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1190/48A (February 19).

PHYSICISTS and MATHEMATICIANS (Experimental Officer grade, unestablished) in Ministry of Supply research and development establishments in Southern England and South Midlands—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.398/48A (February 19).

SENIOR SCIENTIFIC OFFICERS or SCIENTIFIC OFFICERS: (*a*) CHEMIST (research experience on gaseous combustion at high pressures and detonation of solid explosives is desirable), (*b*) PHYSICIST for research on velocity of detonation of gases at high pressures and measurement of explosion pressures, (*c*) CHEMIST for analysis, stability and sensitivity tests on new explosives for industrial use; EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS: (*a*) to assist in new methods of physical testing and in the assessment and investigation of explosion and fire risks, (*b*) for the analysis of explosives samples taken in the field, etc., (*c*) for gas analysis of mixtures of hydrocarbons and other reactants or for physico-chemical work connected with acetylene; in a Ministry of Supply research and development establishment in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1189/48A (February 19).

LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Manchester 13 (February 25).

STATISTICIAN IN THE DEPARTMENT OF SOCIAL AND INDUSTRIAL MEDICINE—The Registrar, The University, Sheffield (February 26).

CHEMIST or CHEMICAL ENGINEER for fundamental, theoretical and experimental work including work on corrosion, a CHEMICAL ENGINEER for development of chemical processes subsequent to the laboratory stage and design of plant from pilot plant to larger scale, a PHYSICIST for design, development, manufacture and operation of special instruments, including automatic controls, for chemical plant, and a MECHANICAL ENGINEER for experimental work on problems of stress measurement and high-pressure technique and for the design of machines and plant for chemical engineering projects, in the chemical engineering section of a Ministry of Supply research and development establishment in Essex—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1188/48A (February 19).

PROFESSOR OF ORGANIC CHEMISTRY, and a PROFESSOR OF THEORETICAL PHYSICS, at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.2 (March 31).

DIRECTOR—The Registrar, Indian Institute of Science, Bangalore 3, India (April 11).

SCIENTIST (Grade III, with honours degree in physics and, preferably, experience in electronics) IN THE SCIENTIFIC BRANCH, North-Western Division of the National Coal Board—The Divisional Establishment Officer, National Coal Board, 47 Peter Street, Manchester 2.

LECTURER IN PHYSICS—The Principal, Derby Technical College, Normanton Road, Derby.

HEALTH PHYSICS AND SAFETY ASSISTANT MANAGER at the Ministry of Supply Division of Atomic Energy, Springfield Factory, Salwick—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington.

SENIOR LECTURER IN PRODUCTION ENGINEERING, MACHINE TOOLS AND JIG AND TOOL PRACTICE in the Department of Aircraft Economics and Production—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.